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EDITORIAL

DURING the summer vacation of 1961, states the report of IAESTE (U.K.) for the year ended September 30 last, 894 students from affiliated universities and colleges were sent abroad for experience, while 965 overseas students arrived in this country and were placed in British industry and commerce. Both the figures named show increases over the corresponding figures for 1960 and bear witness to the usefulness of the work carried out by the Association. The report also shows that since the establishment of IAESTE (U.K.) in October, 1960, generous support has been readily forthcoming from both industrial and educational interests in the United Kingdom.

IN the month past, it is announced, a new shaft-sinking record was established in South Africa. During October the No. 4 shaft at the Western Reefs mine, in the Klerksdorp area, was sunk 1,118 ft, thus breaking the 1,106 ft. previous record established at the Hartebeestfontein mine. In making the announcement the Anglo American Corporation of South Africa, to which group Western Reefs belongs, suggests that the new record is indicative of the continuing progress being made by the gold-mining industry in improving its high-speed shaft-sinking techniques. It is just over two years since President Steyn mine in the Orange Free State achieved what was regarded by experts as the " four minute mile of mining "—the sinking of a shaft more than 1,000 ft. in a month. Since then the record has been broken three more times—by President Steyn a month later, by Hartebeestfontein, and now by Western Reefs. As a measure of this progress it will be recalled that in 1932 a shaft at West Rand Consolidated was sunk 420 ft. in a month, while in March, 1955, a shaft was sunk 667 ft. in a month at Vaal Reefs. This record was broken less than six months later by West Rand Consolidated, which sank a shaft 763 ft. Following that the record was broken several more times before Vaal Reefs regained it with 922 ft. in September, 1959, and then broke it again two months later with 954 ft. In that same month, however, President Steyn's achievement of 1,001 ft. overtook Vaal Reefs' record.

CONCLUDING an address before the Metallurgical Society of the American Institute of Mining, Metallurgical, and Petroleum Engineers last month Mr. James B. Austin, administrative vice-president research and technology of the United States Steel Corporation, whose subject was " Three Centuries of Progress in the American Steel Industry," suggested that the most notable development since the end of the war had probably been the changes in the ore supply. For almost 50 years the main source of iron had been the direct shipping ores of the Lake Superior region and during that period some 2,500,000,000 gross tons of ore had been shipped. Although that supply was by no means exhausted it became evident that other sources must be found. That search had taken two forms. One was exploration for foreign sources of high-grade ore and that was successful notably in Venezuela and in the great Ungava trough of Labrador and Quebec. Both of those areas had now been developed and were contributing to the nourishment of the American industry. In addition, ore was being imported from Chile, Peru, Brazil, Liberia, Mexico, Sweden, and elsewhere. The second search had been for an economical means of up-grading the large resources of low-grade ores remaining in the Lake Superior region. That had led to the successful development of two large taconite concentrating plants. Although those were important the trend toward imports continued and had increased over the last ten years.

The Mining Institutions

In the course of his presidential address to the Institution of Mining and Metallurgy last June, which was reviewed in the July issue,

Mr. A. R. O. Williams remarked that he would " like to see a breaking down of the artificial barrier that has grown up " in this country " between coal and other forms of mining." This barrier, expressed in the existence here of two professional institutions, the Institution of Mining and Metallurgy and the Institution of Mining Engineers, each incorporated by Royal Charter, grew originally out of the difference in outlook engendered by the fact that metal miners trained here principally went abroad for their experience, while engineers intended for the coal industry expected naturally to work in the United Kingdom. There is the additional factor that the Institution of Mining and Metallurgy is itself an entity with branches overseas, while the Institution of Mining Engineers is a federation of local institutes perhaps somewhat more parochial in outlook. However, mining being an art universally applicable whatever the mineral to be won, it would seem, as Mr. Williams suggested, that a closer liaison between the two institutions might be of benefit to all.

An opportunity to refer once again to this matter arises from the inaugural address given last month by Mr. David Hemmant, the new president of the Southern Counties Institute of Mining Engineers. Mr. Hemmant, who believes " that the continued existence of two completely separate professional organizations is perhaps the greatest contributing factor to the continued existence of the barrier between the coal and metal branches " of mining, sees many advantages in closer co-operation. He points out, for instance, that " there are many other subjects in which the two branches of the industry have a common and near equal interest, including strata control, ventilation, pumping and drainage, illumination, machinery maintenance, communications, earth moving, explosives, power distribution, and materials handling ; even mineral dressing has much in common with coal preparation. . . . If a distinction must be made between one kind of mining and another it would be much more logical to make it on physical grounds—*e.g.*, between hard rock and soft material—for there is really as much difference, if not more, between the deep mining of gold . . . and alluvial dredging . . . as between either of these operations and coal-mining in the U.K." Mr. Hemmant then points out that " there is at present no one body to act as a mouthpiece of the mining engineering profession to contribute to the formation of Government policy, to assist in national planning, or for any other purpose ; differences of opinion between the two branches are therefore likely to be resolved by someone with little knowledge of either." In addition, closer co-operation between institutions would naturally lead to a freer exchange of technical information and discussion, a factor which could be of inestimable value in promoting that " mineral consciousness " generally thought necessary if our mining machinery industry is to hold its own in the export trade.

It is of interest to note that Mr. Hemmant in his address referred to a proposed Symposium on haulage to be held in 1964. For such an occasion both institutions could provide material likely to be of mutual assistance and start the ball rolling towards a greater degree of co-operation.

Safety in Mines Research

The report of the Ministry of Power's Safety in Mines Research Establishment for 1960 [1] contains many items that will interest all mining engineers. Apart from the problems related particularly to work in coal mines, such as the explosion hazards associated with methane concentrations and coal dust, matters relating to safety and rescue work concern all underground workers. Again, the pneumoconiosis risk is of common interest and in the year under review the Establishment, it is stated, concentrated on the mineralogy, chemistry, and physics of dusts, on the measurement side the main effort being applied to the development of a readily portable gravimetric sampler employing a membrane filter. It is thought that ultimately the weight of dust in the breathed air may prove easier to measure than the number of particles and also may be better correlated with physiological results. In the autumn of 1959 the National Coal Board started periodical X-ray examinations of all coal miners, the aim being to examine each man every five years. Previously this type of examination had been restricted to new entrants to the industry. When the results of the new work become available they should give a better picture of the prevalence of pneumoconiosis than do the certification

[1] Safety in Mines Research, 1960 ; 39th annual report. Paper covers, 72 pages, illustrated. Price 5s. London : H.M. Stationery Office.

statistics which are the main source of information at present.

Machine and machine component failures are also of common interest. It is suggested that the design of mechanical components often takes insufficient note of the detailed stress distribution, with the result that the component is more prone to failure than it should be, or is inconveniently heavy, or has ill-distributed strength. These aspects have been examined and the design of a new roadhead bar has been completed during the year. Continued attention has also been given to the dynamic loads encountered by a variety of mechanical appliances and the stresses therein resulting, while work on a honeycomb cage-arrester is promising. It can also be noted that the metallurgical inquiries into mechanical failures continue to help in improving component design, particularly when breakdown has been shown to be a fatigue effect.

All in all, as already noted, the report shows the wide basis of the work undertaken by the Establishment. In respect of the investigations into the use of stone-dust barriers in the reduction of the effects of coal-dust explosions it is stated that plans are now being prepared for a full-scale explosion gallery to be built on the site at Buxton. This gallery is to be 400 yd. long with a 60 sq. ft. section and completely instrumented. It should permit of a major advance in the investigations being carried out to combat the explosion hazard.

Royal School of Mines Dinner

This year, as has been the custom for several years past, the annual dinner of the Royal School of Mines Association was held in the Apothecaries' Hall. The date was October 30 and this the 77th such annual gathering, the principal guest being Sir Andrew Cohen, who from 1957 to earlier this year was the Permanent British representative on the Trusteeship Council, United Nations, and is now Director General of the Department of Technical Co-operation at the Colonial Office. Sir Andrew, in proposing the toast of the Association, spoke of the vast change that had taken place in what was once our Colonial Empire, the administration of which, he suggested, had become a " dying occupation." The present problem, he thought, was one of exporting knowledge, particularly what was called " technical know-how," to a host of countries rapidly emerging into full-fledged political independence. The need for help in such countries was at present hard to supply and Sir Andrew wondered, in his present position, whether such technological institutions as the Royal School of Mines were " geared-up " to take their part in what was something of an emergency. He spoke of the " mining process," the whole gamut of procedures from preliminary survey through prospecting and exploitation to processing and hoped that the men were as ready in this country as they were in some others to give the help that was patently needed. It was in his position at the head of his new Department that members of the Association should be able to give him support and encouragement.

It was in this respect that Mr. Peter Best, president of the Association, was in his reply able immediately to promise both help and interest. He felt, however, that technological students needed authoritative guidance if they were to be persuaded that the type of service they could offer would be utilized. Such service would be particularly valuable if requisite experience had previously been gained. Referring to domestic matters he said that at the Royal School of Mines itself the reconstruction of facilities was proceeding rapidly and he was happy in the fact that in the current year there were 84 freshers, against 67 a year ago, and that among new courses instituted there was one on deep mining. The president's chief concern, however, was with the gaining of experience, a matter that he had mentioned previously. He wondered if industry itself could not do more itself to help. He suggested, for example, that schemes could be devised whereby junior engineers on the staffs of the various mining groups could exchange jobs over restricted periods, a matter in which, he thought, the various Chambers of Mines might be able to help. Finally the president referred to the publication of the new R.S.M. register, expressing the gratitude of all members for the work that had been done in its compilation by their devoted Secretary, Dr. J. H. Watson, and his wife.

The toast of the guests was happily proposed by Mr. D. T. Hudson, the senior vice-president, the response coming from Mr. R. H. MacWilliam, who also expressed his concern at the rapid political developments overseas. While, he felt, such developments could well lead to restriction of certain openings for employment, he was also sure that technological knowledge would always be needed.

MONTHLY REVIEW

Introduction.—The general air of confidence in the economic situation displayed by the Chancellor of the Exchequer in the House of Commons during the debate on the Queen's speech has not been without effect. There is strong hope of better times in the coming year, when better commodity prices, including those for the depressed metals, lead and zinc, may be expected.

South Africa.—The output of the member gold-mining companies of the Transvaal and Orange Free State Chamber of Mines for September totalled 1,921,304 oz. and that from other producers 37,228 oz., a grand total of 1,958,532 oz. for the month. At the end of September there were 381,659 natives at work in the gold mines, as compared with 382,733 at the end of the previous month. The operations of the member mines in the three months to September 30 resulted in a total profit of R67,147,350.

Last month the CONSOLIDATED GOLD FIELDS OF SOUTH AFRICA announced that the Ventersdorp Contact Reef had been intersected at a depth of 6,517 ft. in Borehole No. 24, located approximately one mile outside the south-eastern boundary of the Libanon mine. The reef assayed 86·8 dwt. per ton over a corrected width of 33·9 in. The hole is to be continued to the Main Reef Group before being deflected for a further intersection of the Ventersdorp Contact Reef. It was also announced by WEST WITWATERSRAND AREAS that the first deflection of Borehole No. E.8.L on Farm Kleinfontein 141 re-intersected the Carbon Leader at a depth of 9,085 ft., assaying 5·7 dwt. gold per ton over a corrected width of 7·8 in.

The operations of WEST DRIEFONTEIN GOLD MINING for the year to June 30 last resulted in a profit of R27,668,640, dividends equal to 60 cents a share requiring R8,449,296. In the year 1,643,500 tons of ore was milled and 1,490,388 oz. of gold recovered, while 193,912 lb. of uranium oxide was also produced. Ore reserves were estimated as 4,091,000 tons, averaging 14·6 dwt. in gold with 0·24 lb. of uranium oxide per ton.

DOORNFONTEIN GOLD MINING has acquired an option over about 1,621 claims adjoining the north-eastern and north-central boundary for five years from 1961 to prospect and purchase the whole or part of the area at about R764 a claim. Prospecting has not yet commenced. VENTERSPOST GOLD MINING has also acquired a prospecting permit over about 311 claims adjoining the deep-level eastern boundary, into which it is expected that orebodies extend to some extent at least. Indications are that the dip of the orebodies tend to flatten somewhat at depth. Unless a down-throw fault exists in or near the eastern section and a fault system has been located just to the north of the prospecting area the depth of the orebodies in that area may not exceed 6,000 ft. to 7,000 ft. to any great extent. In the year to June 30 last Doornfontein treated 1,317,500 tons of ore and recovered 547,958 oz. of gold and 97,619 lb. of uranium oxide. Operations resulted in a profit of R6,468,399 of which dividends equal to 27 cents a share required R2,653,560.

The accounts of SUB NIGEL for the year to June 30 last show a profit of R342,252 and R433,966 available, of which R428,050 has been transferred to capital reserve. In the year 180,470 oz. of gold was produced from 793,000 tons of ore milled.

During the year to June 30 last HARTEBEESTFONTEIN GOLD MINING treated 1,522,000 tons of ore and recovered 704,823 oz. of gold. In addition 1,013,901 lb. of uranium oxide were sold. The profit for the year was R11,880,239, of which R4,500,000 was required for dividends equal to 50%.

Trial milling has been started by WESTERN AREAS GOLD MINING in its section of the Randfontein mine gold plant to the north and production may be officially commenced before the year-end. To the end of September, 1961, capital expenditure amounted to R15,072,000. The mine has been brought to the producing stage about 18 months ahead of schedule. The main shaft, 26-ft. lined diameter, sunk to a final depth of 4,980 ft., has a mill-feed supply capacity of 200,000 ton a month but initial milling will be at the rate of about 50,000 tons monthly. Drilling in the lease area indicated a Ventersdorp Contact Reef grade of 426 in.-dwt. and payability of about 50% and an Elsburg Reef grade of 353 in.-dwt. and payability of about 70%. A characteristic erratic mineralization or value trend was disclosed in drilling.

The operations of RAND LEASES (VOGELSTRUISFONTEIN) for the year to June 30 last resulted in a surplus of R81,969. From 2,272,000 tons of ore milled 316,607 oz. of gold was recovered.

TRANSVAAL GOLD MINING ESTATES has purchased additional mineral rights in the Pilgrims Rest district of the Eastern Transvaal. This indicates a possible extension of mining complex gold-copper sulphide ore for the production of concentrates, which are roasted in a fluo-solid roaster. The sulphur dioxide is converted into acid for the conversion of phosphate concentrate from Phalaborwa into superphosphate, while the calcined product is shipped and sold overseas.

In the year to June 30 BLYVOORUITZICHT GOLD MINING treated 1,622,000 tons of ore which yielded 1,046,542 oz. of gold, while 757,875 lb. of uranium oxide was also produced. For the year a profit of R9,622,192 was made, dividends equal to 26 cents a share requiring R6,240,000. Total ore reserves are given as 6,136,000 tons averaging 13·6 dwt. in gold and 0·565 lb. of uranium oxide per ton.

In the September quarter ROOIBERG MINERALS DEVELOPMENT treated 41,206 short tons of ore and recovered 295 long tons of tin concentrates. The estimated working profit for the period is given as R92,654. In the year to June 30 last 162,321 tons was treated for 1,134 tons of concentrates. For that period operations resulted in a profit of R207,925.

ZAAIPLAATS TIN MINING treated 63,985 short tons of ore in the year ended July 31 last and recovered 375 long tons of tin concentrates. The accounts for the year show a profit of R142,826, of which dividends equal to 27½ cents a share required R107,101.

In the three months ended September 30 last MESSINA (TRANSVAAL) DEVELOPMENT produced 309,110 long tons of ore containing 3,794 tons of recoverable copper.

SOUTH AFRICAN COAL ESTATES (WITBANK), which in the 1960–61 year completed the re-organization of mining operations at its Landau No. 3 pit to mine both the top and lower coal on a more highly mechanized system and commissioned a washing plant connected with the underground workings by a conveyor-belt system, expects that with the regular annual rise in coal consumption the company's plans to open up a new pit, No. 4, in the 1970's may have to be brought forward several years. The position will be reviewed annually and adequate financial reserves will meanwhile be built up. The availability of African labour has been plentiful.

The pattern of drilling by FREDDIES CONSOLIDATED in its exploratory programme on the Elsburg and Kimberley Reef horizons in the western section (representing an extension of the orebody from the neighbouring Loraine mine) suggests that the persistence on strike may be of the order of about 4,000 ft. from the common boundary with Loraine. A third surface borehole has been sited about 3,950 ft. south of ERK 1, which is on the common boundary. At September 30 a depth of 3,088 ft. had been reached in the third borehole and the shallowest band of the Elsburg Series should be intersected, if present, within the next 1,000 ft. or so. The indicated borehole grade range of the Elsburg bands is 342 in.-dwt. to 463 in.-dwt. and payability 40% to 45% ; the Kimberley Reef grade range 270 in.-dwt. to 280 in.-dwt. and payability about 40%. The erratic mineralization indicates a selective mining policy. The relatively limited area (so far defined by drilling) of deposition suggests a link-up with the Loraine mine where the borehole grade range in the Elsburg bands was about 500 in.-dwt. to 780 in.-dwt.

The accounts of HARMONY GOLD MINING for the year to June 30 last show a profit of R13,349,479, of which dividends equal to 27·65 cents a share required R4,995,000. The mill crushed 2,116,000 tons of ore in the year and recovered 857,794 oz. of gold and 974,349 lb. of uranium oxide. The total ore reserves at June 30 were estimated to be 5,651,000 tons averaging 8·4 dwt. in gold and 0·563 lb. of uranium oxide per ton.

The mill at FREE STATE SAAIPLAAS started trial running at the end of September, 1960, and normal operations at the beginning of the current year. In the six months to June 30 last 320,500 tons of ore was crushed and 82,001 oz. of gold recovered.

Southern Rhodesia.—It is reported from Salisbury that RHODESIAN SELECTION TRUST EXPLORATION has been granted an exclusive prospecting order for nickel over 146 square miles in the Hartley Mining District. The company has been called upon to spend £35,000 on operations within the reservation area before the end of September, 1964.

In the three months to September 30 last M.T.D. (MANGULA) milled 345,000 short tons of ore and recovered concentrates containing 3,647 long tons of copper.

It was announced earlier this month that the mine of RHODESIA MONTELEO ASBESTOS was

closed down at the end of October, it having proved impossible to maintain profitable operation.

Northern Rhodesia.—The BRITISH SOUTH AFRICA COMPANY recently announced that its estimated revenue from mineral royalties, rents, and fees for the quarter ended September 30, after providing for the payment to the Northern Rhodesia Government of 20% of the net revenue derived from the exercise of its Mineral Rights in Northern Rhodesia, amounted to £2,607,000.

Ghana.—It was reported from Accra last month that the Government had taken over the property of the HOLLAND SYNDICATE at Takrowase, near Akwatia.

Nigeria.—In the year ended March 31 last AMALGAMATED TIN MINES OF NIGERIA produced 4,808 tons of cassiterite and 722 tons of columbite, operations resulting in a profit of £430,671, of which dividends equal to 25% require £298,594. In his statement accompanying the report and accounts for the year the chairman draws attention to the need to go ahead with the equipment replacement programme. It is expected that the provision of new earth-moving machines will involve expenditure of over £1,000,000.

Tanganyika.—In a progress report covering the three months to September 30 last shareholders of KENTAN GOLD AREAS are informed that in the period GEITA GOLD MINING milled 67,560 tons of ore and recovered 11,088 oz. of gold. The report states that in order to obtain access to the orebody below adit (4th) level in the North-east Extension of the mine it has been decided to sink an incline shaft from surface to the 8th level horizon. This shaft is to be known as " The Independence Shaft " and financed from the Geita company's own resources.

Australia.—At the end of October shareholders of NORTH BROKEN HILL and BROKEN HILL SOUTH LIMITED were informed that subject to the consent of the Minister for Mines of New South Wales the companies had agreed in principle for the sale of the leases comprising the British-Junction Section of North mine to Broken Hill South, consideration for the sale of the leases to be 450,000 fully-paid shares of 5s. each in Broken Hill South. The majority of those employed at the British-Junction Section will, it is stated, be transferred to the employment of Broken Hill South and the balance retained in the employment of North Broken Hill.

A note in the September issue drew attention to the offer of CONSOLIDATED GOLD FIELDS (AUSTRALIA) to acquire a majority interest in ASSOCIATED MINERALS CONSOLIDATED. This offer, it has been announced, was successful. Now Associated Minerals has made an offer to acquire the shares of Z. R. HOLDINGS, a company incorporated in the State of Victoria, whose subsidiaries work extensive deposits of rutile and zircon-bearing beach sands in New South Wales and Queensland. The issued capital of Z. R. Holdings is 1,204,801 shares of 10s. (Australian) each, and the profit of the company, after tax, for the year ended June 30, 1960, amounted to £A115,157. The offer is given as one Associated Minerals share and 8s. (Australian) cash for every three Z. R. Holdings shares.

The new sinter plant of the BROKEN HILL PROPRIETARY CO. at Newcastle has been completed and is now in production, work on this project having been commenced three years ago. Its capacity is between 24,000 tons and 36,000 tons of sinter per week and the cost approximates £A10,000,000. The new sinter machine is among the largest in the world, it is stated, with a grate area of 2,236 sq. ft. A large part of the feed to the blast-furnaces will now be sintered before delivery to the furnaces. Accessory equipment comprises ship unloading facilities, ore-handling equipment, and a section for screening and crushing coke and limestone. The plant contains 90 conveyor-belts with a total length of three miles. It is connected throughout by a public address system and a closed-circuit television unit permits vital parts to be watched continuously. The necessity and advantages of this plant were evident on account of the friable nature of the ore from Cockatoo Island, Yampi Sound, Western Australia.

At an extraordinary meeting of the WESTERN MINING CORPORATION held last month the increase in the company's capital to £5,000,000 by the creation of 16,000,000 new 5s. shares was approved.

In the three months to September 30 last the MOUNT LYELL MINING AND RAILWAY COMPANY treated 535,629 tons of ore and produced concentrates containing 2,471 tons of recoverable copper. The smelter production amounted to 3,542 tons of blister copper.

Malaya.—Shareholders of IPOH TIN DREDGING have been informed that dredging operations during the first six months of the current year have shown a loss of approximately £20,000—that is, in addition to the £13,000 overall loss for the year ended

March 31, 1961. The directors are taking steps to cease mining operations and to dispose of the company's assets in Malaya.

India.—In a recent statement to shareholders the chairman of the INDIAN COPPER CORPORATION announced that the suit with the Bihar Government regarding the lease of the kyanite property had been settled amicably. Operations for mining kyanite, most of which is exported, can now go forward on a basis considered fair to both parties.

Canada.—A note from our Toronto correspondent in the MAGAZINE for February last referred to the results being obtained by diamond drilling in Joutel township, in north-western Quebec. CAMP BIRD MINING and other participants in the venture have now agreed to the formation of a new company, JOUTEL COPPER MINES, to take over the properties. It is hoped once finance is arranged to sink a shaft to 1,000 ft. in order that the orebodies can be opened up. It has been estimated that some 1,000,000 tons of ore averaging 2% to 3% copper has been outlined.

DIVIDENDS DECLARED

* Interim. † Final.

(Less Tax unless otherwise stated.)

†**Amalgamated Tin Mines of Nigeria.**—9d., payable Nov. 30.

***Broken Hill South.**—5d. Aust., payable Dec. 15.

***Central Norseman Gold Corporation.**—1s. 9d. Aust., payable Dec. 7.

†**Chenderiang Tin Dredging.**—7½d., payable Nov. 27.

†**Consolidated Gold Fields of South Africa.**—3s. 9d., payable Dec. 20.

***Consolidated Zinc Corporation.**—9d., payable Jan. 1.

***General Mining and Finance Corporation.**—3s., payable Dec. 4.

***General Tin Investments.**—9%, payable Nov. 23.

†**Gold Estates of Australia.**—4d.

***Gold Mines of Kalgoorlie (Aust.).**—6d. Aust., payable Dec. 1.

***Gopeng Consolidated.**—1s., payable Nov. 18.

†**Kamunting Tin Dredging.**—1s. 10½d., payable Nov. 30.

†**Kepong Dredging.**—1s., payable Jan. 26.

†**Lake View and Star.**—1s. 6d., payable Dec. 14.

†**Lampa Mining.**—12½%, payable Dec. 21.

†**Loloma (Fiji) Gold Mines.**—6d. *plus* 9d. Aust., payable Dec. 15.

†**London and African Mining Trust.**—3d., payable Nov. 15.

***London Tin Corporation.**—7½%, payable Nov. 30.

†**Lower Perak Tin Dredging.**—1s. 6d., payable Dec. 6.

†**M.T.D. Mangula.**—3s. 6d., payable Dec. 29.

***McIntyre Porcupine Mines.**—25 cents, payable Dec. 1.

†**Malayan Tin Dredging.**—6d., payable Dec. 29.

National Mining Corporation.—†¾d., and *1½d., payable Nov. 30.

***New Broken Hill Consolidated.**—6d., free of tax, payable Jan. 1.

†**New Guinea Goldfields.**—3d. Aust.

†**North Kalgurli (1912).**—6d., payable Dec. 14.

†**Offin River Estates.**—3¾d., payable Dec. 14.

†**Pahang Consolidated Co.**—1s. 3d., payable Dec. 30.

***Pengkalen.**—6d., payable Nov. 24.

†**Rahman Hydraulic Tin.**—10% and 10% bonus, payable Dec. 9.

†**Southern Malayan Tin Dredging.**—1s. 6d., payable Dec. 29.

***Sungei Besi Mines.**—1s. 3d., payable Nov. 28.

***Tanjong Tin Dredging.**—1s., payable Nov.25.

***Tehidy Minerals.**—4%, payable Nov. 15.

***Union Corporation.**—6½ cents, free of U.K. Tax.

Correction.—It is regretted that in the October issue it was stated that **Selection Trust, Ltd.,** had declared a final dividend of "4s., payable Dec. 18". In fact, that company, as London Paying Agents of **Mufulira Copper Mines, Ltd.,** had only announced the intentions of the directors of the last-named company.

METAL PRICES

Nov. 8.

Aluminium, Antimony, and Nickel per long ton; Chromium per lb.; Platinum per standard oz.; Gold and Silver per fine oz.; Wolfram per unit.

	£	s.	d.
Aluminium (Home)	186	0	0
Antimony (Eng. 99%)	230	0	0
Chromium (98%–99%)		7	2½
Nickel (Home)	660	0	0
Platinum (Refined)	30	5	0
Silver		6	8
Gold	12	10	1¼
Wolfram (U.K.)		—	
(World)	5	8	0

Tin, Copper, Lead, Zinc } See Table, p. 300

A Note on Zone Refining

A technique used in the preparation of high-purity metals is briefly reviewed

W. H. Dennis, B.Sc., M.I.M.M.

Introduction

The advent of atomic energy, electronics, and now space technology has led to a demand for metals of a very high order of purity and this has necessitated the development of new purification methods. Among these the application of a technique known as zone refining has now become well established. As a process this dates back to 1953, when W. G. Pfann, in the United States, first applied the method to the purification of germanium for use in transistors. He found that when a rod of impure metal (Fig. 1) is heated so as to cause a molten zone to pass down its length, impurities tend to be carried forward in the molten zone towards one end of the rod. By repeating the process a number of times a high degree of impurity was achieved. The technique has since been applied to a wide range of metals.

Practical Techniques

A relatively narrow zone about 1-in. long is formed in a long bar of the material contained in a crucible by means of heat from a high-frequency source (Fig. 2). As the hot zone is moved slowly (a few inches per hour) along the bar successive portions become molten, the impurities being carried forward in the molten portion, pure metal concentrating from the back of the moving zone. The concentration of impurities is thus increased in the direction of zone movement. By repeated applications of the process a high degree of purification is reached. Thus five traverses suffice to reduce the level of impurity in germanium and silicon to one part in 10^9.

The establishment of a zone of maximum temperature with a cool region on either side of the zone is commonly effected by induction heating in which the metal is surrounded by a water-cooled coil which constitutes the primary coil. Alternating current of high frequency is applied to the coil which induces secondary currents in the metal, the resistance of the metal to the flow of current resulting in the production of heat which melts the metal. The temperature to which the metal will rise for a given power input is governed by the frequency employed, the conductivity of the metal, and heat losses due to radiation and convection. An interesting feature is that due to electromagnetic action eddy currents are produced which impart some degree of stirring in the molten zone thereby increasing the efficiency of the refining action.

Floating Zone Techniques.—Certain elements are so intensely reactive that heating

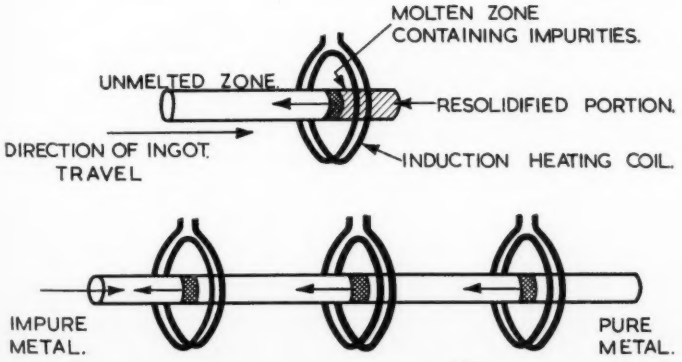

Fig. 1.

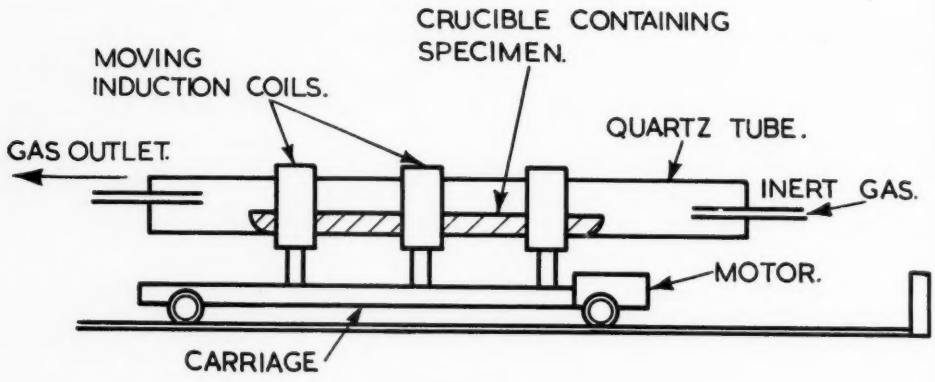

Fig. 2.

in a crucible leads to contamination of the metal by the crucible material, so that it is necessary to guard against such contamination. To avoid it methods of zone refining without a container have been devised. In this operation—known as the floating zone technique—the rod of material is clamped at each end in a vertical position. A moveable ring-shaped heater produces a molten zone held in place by its own surface tension. Induction heating (Fig. 3*a*) is commonly used for the floating zone technique although electron bombardment has also been used. In this method a stream of electrons generated by a tungsten filament wire (Fig. 3*b*) surrounding the rod are deflected to it by a potential difference of several kW. Focusing plates maintained at or below cathode potential control the length of the bombarded zone. A high vacuum appears to be an essential requirement for this form of zone refining.

Principles of Zone Refining

When an impure liquid metal is cooled the solid that crystallizes out has a composition different from that of the molten metal. In a binary system AB, for which the solid solution extends from A to point B (Fig. 4), the upper curve A E E_1 B represents the liquidus and shows the beginning of freezing, while A D D_1 B is the solidus and indicates the end of freezing. An alloy of composition F on cooling down from the liquid state

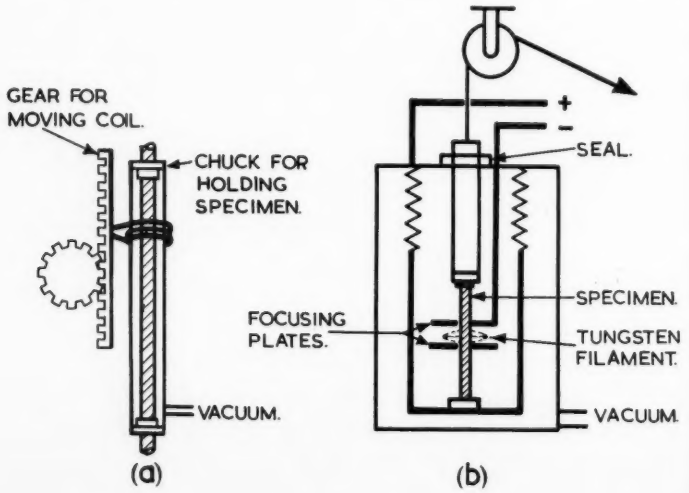

Fig. 3.

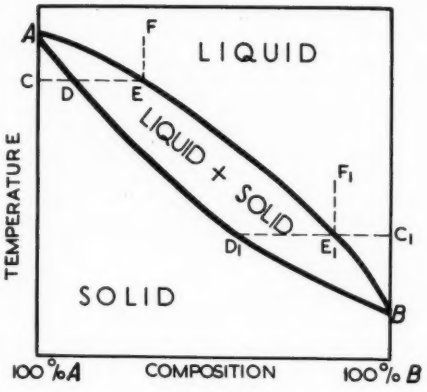

Fig. 4.

begins to freeze at point E on the liquidus, a solid composition D separating. This solid is richer in the higher melting component A from which it came, but still contains component B; if the original composition corresponds to point F then the solid first deposited will have composition D. The solid is thus richer in component A than the liquid from which it has been deposited, whatever the initial composition of the liquid.

Segregation Constant.—In discussing the zone refining of mixtures it is convenient to consider a segregation or distribution constant (k) which can be defined as the ratio of the solid and liquid solubility of one element in the other. Thus, when the original composition is F (Fig. 4), the coefficient $k = \frac{CD}{CE}$; when the original composition is F_1, the coefficient equals $\frac{D_1C_1}{C_1E_1}$. The value of k is thus less than unity for composition F and greater than unity for composition F_1.

Zone refining is normally used on material already of high purity and theory is therefore concerned with points of the phase diagram near the right- and left-hand axes. From a study of such diagrams equilibrium values of k can be found and it has been shown that k is less than unity when the impurity depresses the melting point of the main component and more than unity when it raises it. If the presence of the impurity has no effect on the melting point of the main component then k is unity and no purification of the component is possible by zone refining. The value of this coefficient thus governs the chance of successfully separating one element from the other. In general the smaller the k value the more successful the purification (Fig. 5). Thus one or two zone traverses usually suffice to remove all but unimportant traces of such elements as indium ($k = 0{\cdot}001$) and antimony ($k = 0{\cdot}004$) with low segregation constant from a germanium sample. On the other hand several additional passages are usually necessary to reduce the gallium ($k = 0{\cdot}10$) and phosphorus ($0{\cdot}12$) to an economic level.

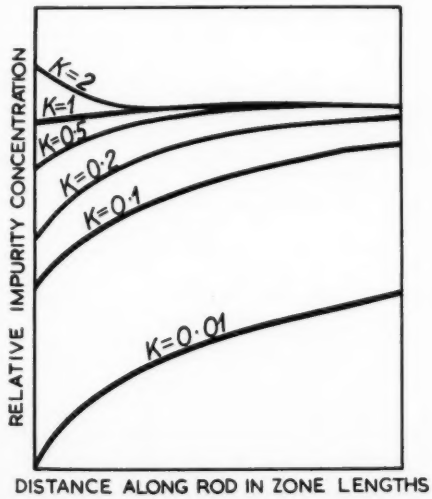

Fig. 5.

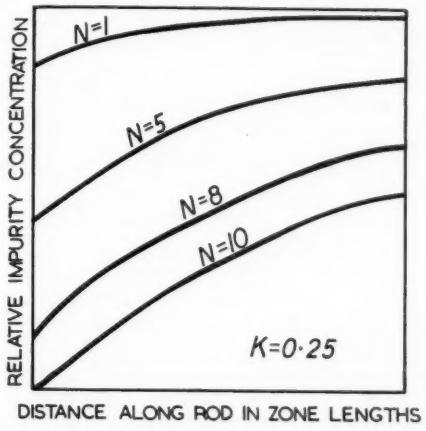

Fig. 6.

Although a fair amount of refining can be effected in one traverse of the bar usually

liquid containing some impurity is trapped in the growing crystals. Effective purification can, however, be increased by an increase in the number of traverses. Fig. 6 illustrates the distribution of impurity after the passage of 1, 5, 8, and 10 traverses where k possesses the value of 0·25.

Applications

The technique is widely used for the purification of the semi-conductor materials germanium and silicon employed in making diodes and transistors. Zone refining of uranium and other metals employed in nuclear energy such as zirconium and niobium is also now well established. Many organic and inorganic chemicals are also treated by the method to yield analytical reagents of high purity.

In addition to purification the technique can also be used to distribute a desired impurity uniformly throughout a metal specimen, segregation being prevented. One method is to traverse in the same direction around a bar made in the form of a ring.

It is perhaps necessary to indicate that as yet metal refining by the zone technique is restricted to small-scale work, 5 lb. or 6 lb. being the commercial weight for usage. As industrial use of the process increases large-scale processes will doubtless be found feasible.

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(2) PFANN, W. G. Zone Melting. John Wiley and Sons, Inc., N.Y.

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Behaviour of Beach Sands in High-Tension Electrostatic Separators

K. K. Majumdar [1]

The results of studies carried out in Bombay are recorded

Abstract

In the recovery of economic beach sand minerals electrostatic and high-tension separation play a very important part. In the present paper the behaviour of some important minerals from beach sands of Kerala State, India, in high-tension and electrostatic separators, have been investigated under different conditions—*e.g.*, polarity of the charged electrode, its position relative to the rotor and the fine wire used for corona discharge, the speed of the rotor, etc. It has been found that conducting minerals such as ilmenite and rutile are best separated in an electrostatic separator, with the charged electrode having positive polarity, the r.p.m. of the rotor (6 in. in diameter) being about 36. Ilmenite and rutile responded like a non-conductor in a convective, or a mixed, field—convective and electrostatic. Zircon and quartz responded like normal non-conducting minerals and the best separation took place in a mixed field with either polarity of the charged electrode, the negative being slightly better when the speed of the rotor was rather low (r.p.m. 74).

[1] Metallurgy Division, Atomic Energy Establishment, Trombay, Bombay-71, India.

In the separation and recovery of economic minerals from beach sands electrical separation basing on difference in the conductivity of minerals plays a very important part. In Australia the minerals in some plants are broadly separated into conducting and non-conducting minerals by electrostatic separation before other methods of separation are adopted. In India—that is, in Chavara, Kerala State—electrostatic separation is adopted for the treatment of non-magnetic residues after the removal of ilmenite by electro-magnets. Along with electrostatic separators, high-tension separators are also used nowadays.

In a recent paper [(1)][1] the author has reported the behaviour of natural graphite in

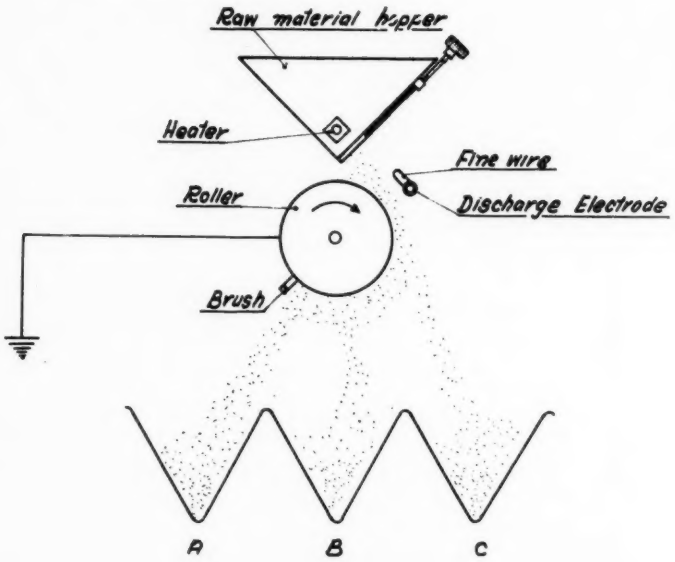
[1] References in parentheses made in the text are given at the end of this article.

Table 1.—Behaviour of Ilmenite, Rutile, Quartz, and Zircon in a Carpco High-Tension Laboratory Separator.

[Diameter of the rotor = 6 in.]

Slide No.	*Mineral*	*Nature of field*	*Polarity of the electrode*	*Static voltage (maximum)*	*r.p.m. of the earthed rotor*	*Conductor (%)*	*Middling (%)*	*Non-conductor (%)*	*Position of electrode (see Fig. 2)*
(1)	*Ilmenite*	Electrostatic	+	18,000	36	58·6	40·5	0·9	3
	− 65 + 100 mesh								
(2)	,,	,,	−	18,000	36	18·8	81·0	0·2	1
(3)	,,	Mixed	+	20,000	74	25·4	24·4	50·2	1
(4)	,,	,,	−	28,000	74	32·3	28·0	39·7	1
(5)	,,	,,	+	20,000	198	37·9	59·2	2·9	1
(6)	,,	,,	−	20,000	198	27·8	71·3	0·9	1
(7)	,,	Convective	+	14,000	198	1·2	97·8	1·0	2
(8)	,,	,,	−	22,000	198	5·6	92·9	1·5	2
(9)	,,	,,	+	20,000	74	0·4	66·9	32·7	2
(10)	,,	,,	−	18,000	74	9·5	82·2	8·3	2
(11)	*Rutile*	Electrostatic	+	20,000	32	62·8	36·1	1·1	3
	− 65 + 100 mesh								
(12)	,,	,,	−	21,000	32	8·8	90·9	0·3	3
(13)	,,	Mixed	+	28,000	86	14·2	13·5	72·3	1
(14)	,,	,,	−	28,000	86	24·3	19·5	56·2	1
(15)	,,	,,	+	24,000	212	11·6	81·8	6·6	1
(16)	,,	,,	−	28,000	212	5·4	90·5	4·1	1
(17)	,,	Convective	+	16,000	86	0·0	35·2	64·8	2
(18)	,,	,,	−	18,000	86	0·3	36·0	63·7	2
(19)	,,	,,	+	16,000	212	1·3	92·0	6·7	2
(20)	,,	,,	−	18,000	212	1·2	86·8	12·0	2
(21)	*Zircon*	Electrostatic	+	18,000	48	17·8	81·8	0·4	3
	− 35 + 100 mesh								
(22)	,,	,,	−	14,000	48	5·0	94·7	0·3	3
(23)	,,	Mixed	+	30,000	74	0·0	2·2	97·8	1
(24)	,,	,,	−	30,000	74	0·0	0·6	99·4	1
(25)	,,	,,	+	30,000	198	0·2	26·4	73·4	1
(26)	,,	,,	−	30,000	198	1·0	70·9	28·1	1
(27)	*Quartz*	Electrostatic	+	30,000	30	2·6	97·1	0·3	3
	− 27 + 35								
(28)	,,	,,	−	30,000	30	0·5	93·3	6·2	3
(29)	,,	,,	+	30,000	74	12·6	87·1	0·3	3
(30)	,,	,,	−	36,000	74	8·7	90·8	0·5	3
(31)	,,	Mixed	−	30,000	74	0·2	2·6	97·2	1

Fig. 1



electrostatic and high-tension separators under different conditions. In the present paper the behaviour of some of the important minerals associated with beach sands in Kerala State, India, has been studied. The minerals, excepting quartz, were obtained from Travancore Minerals (Private), Ltd., Quilon, India, as purified specimens from their plants. The minerals were passed only once through a Carpco high-tension separator (Fig. 1) under different settings of the electrode and the wire (Fig. 2) producing (1) a combination of convective and electrostatic field ; (2) a convective field, and (3) an electrostatic field.[2] The polarities of the electrodes and the speed of the rotors were varied. The feed was screened and dried by heating to about 110° C. for one hour before feeding into the hopper of the Carpco separator, which was also heated. The results are shown in Table 1.

It will be seen from the table that ilmenite responds best under condition of electrostatic separation, with the electrode having positive polarity (Fig. 2, position 3). At low r.p.m., depending on the polarity of the electrode, between 51% and 40% of ilmenite became pinned to the rotor under a mixed field

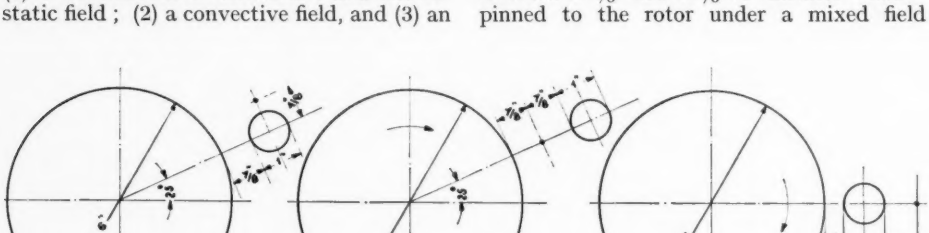


Fig. 2.—Electrode Positions.

(Fig. 2, position 1). Such behaviour is not normally expected of a conducting mineral such as ilmenite. Similarly, rutile behaved as ilmenite, the best condition of separation being electrostatic field with positive polarity of the electrode. Zircon responded best in a mixed field (Fig. 2, position 1), the recovery being the highest with negative polarity of electrode at low r.p.m. of the rotor (about 74). The behaviour of quartz was similar to that of zircon.

Acknowledgement.

The author's thanks are due to Dr. Brahm Prakash, Head of the Metallurgy Division, Atomic Energy Establishment, Trombay, Bombay, for his interest in the problem and also to the Travancore Minerals, Ltd., Quilon, for supplying pure specimens of ilmenite, rutile, and zircon.

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(1) MAJUMDAR, K. K., *Journal of Scientific and Industrial Research*, 1960, Vol. 19B, No. 8, pp. 314–15.

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Controlled Swivel for Wire Ropes[1]

A. Seetharam, B.Sc., B.E., M.I.E.

Experiences with deep winds on the Kolar Gold Field are described.

Appendix C

Discussion by J. T. M. Taylor[2]

The author is to be congratulated on bringing together the history of the difficulties which have been experienced over a period of more than ten years in the installation of Gifford shaft ropes. This problem and the solution, which has been worked out after much effort, are probably unique and it has not been possible to adopt a solution already worked out in any other mining camp. The practical aspects are fully covered in the paper, but it is also useful and instructive to study the theoretical aspects. As a result of work done on the field it is possible to work out a mathematical theory from which the behaviour of any set of ropes as regards the important factors of torque and pitch can be accurately predicted. For this it is necessary to know certain characteristics of the rope and, even if these have to be estimated empirically, reasonably accurate results can be obtained.

In deriving the theory of torque in long winding ropes, the following notation can be used :—

a, torque-deflection coefficient.
d, diameter of wires in rope, in.
L, length of rope, in.
n, number of lay pitches (or turns) in length L.
p, lay pitch, in.
P_o, lay pitch at which rope has no torque at no load, in.
R, radius to centre of strands, in.
T, torque, lb.-in.
W_s, load suspended at end of rope, lb.
W, total load in rope at any point, lb.
w, weight of rope, lb per in.
α, angle of strands to rope axis.
θ, angle of wires to strand axis.
ψ, angular rotation in length, L, of rope.

Torque is produced in a wire rope by two factors: (1) Torque due to load and (2) torque due to twisting.

(1) When a load is applied to a rope a torque is produced due to the helical formation of the strands. If the load in the rope is W the axial load in the strands will be $W \sec \alpha$, where α is the angle between the strand axis and the rope axis. The torque produced by the strands will then be

[1] Concluded from the October issue, p. 213.
[2] Messrs. John Taylor and Sons.

$WR \tan \alpha$. If the rope is Lang's lay the torque will be further increased by the similar effect of the wires about the strand axis.

For the simple case of a 6 by 7 rope the torque due to the wires will be $\frac{6}{7} Wd \tan \theta$. Thus the total torque due to load

$$= W(R \tan \alpha + \frac{6}{7} d \tan \theta) \quad . \quad (1)$$

This formula cannot be applied to complex flattened-strand ropes such as Gifford's and therefore the effect of the wires in the strand is provided for empirically in the following formula :—

Torque due to load $= WR' \tan \alpha$, where R' is the effective radius, taken as $1 \cdot 3R$.

(2) It has been found experimentally by Layland, Rao, and Ramsdale [1] that the torque varies lineally with angle of twist or untwist up to the point where the lay starts to open. This can be expressed in the form of a torque-deflection coefficient—

$$a = \frac{TL}{\phi} \quad . \quad . \quad (2)$$

Combining 1 and 2 the total torque in a rope is

$$T = WR' \tan \alpha + \frac{a\phi}{L} \quad . \quad (3)$$

Considering a long rope hanging in a shaft, W, the load on the rope will vary because of the weight of the rope itself. Since in equilibrium the torque cannot vary along the rope it follows that $\frac{\phi}{L}$ must vary ; $\frac{\phi}{L}$ is the amount of twist taken out or put into the rope in unit length—

$$\therefore \phi = 2\pi(n - N_o) \quad . \quad . \quad (4)$$

Also, neglecting changes in the length of the rope,

$$np = N_o P_o = L$$

$$\therefore \phi = 2\pi L\left(\frac{1}{p} - \frac{1}{P_o}\right). \quad . \quad (5)$$

From the geometry of the rope,

$$\tan \alpha = \frac{2\pi R}{p} \quad . \quad . \quad (6)$$

Therefore, from 3, 5, and 6,

$$T = \frac{2\pi RR'W}{p} + 2\pi a\left(\frac{1}{p} - \frac{1}{P_o}\right)$$

Whence,

$$p = \frac{RR'W + a}{\frac{T}{2\pi} + \frac{a}{P_o}} \quad . \quad . \quad (7)$$

Equation 7 gives the relation between the pitch at any point along the length of the rope and the load on the rope at that point and the torque, but it does not enable the torque to be calculated. To find the torque it is necessary to consider the equilibrium of the whole of the suspended part of the rope. At a point distance, x, from the cappel, from 7 we get—

$$p = \frac{RR'(W_s + wx) + a}{\frac{T}{2\pi} + \frac{a}{P_o}} \quad . \quad . \quad (8)$$

The controlling factor is the number of turns in the rope, which remains constant except when twist is being released with a swivel. Thus, lengthening of the pitch at one point in the rope must be accompanied by shortening at some other point. The number of turns in length, L, is given by :—

$$n = \int_o^L \frac{dx}{p}$$

From (8) ·

$$n = \int_o^L \frac{\frac{T}{2\pi} + \frac{a}{P_o}}{RR'(W_s + wx) + a}$$

$$= \frac{\left(\frac{T}{2\pi} + \frac{a}{P_o}\right)}{RR'w} \log \frac{RR'(W_s + wL) + a}{RR'W_s + a}$$

$$\therefore T = \frac{2\pi RR'wn}{\log \frac{RR'(W_s + wL) + a}{RR'W_s + a}} - \frac{2\pi a}{P_o} \quad (9)$$

Equation 9 enables the torque in a long rope to be calculated in terms of the characteristics of the rope and the load on its end. It will be seen that if twist is removed from the rope—*i.e.*, n is reduced—the torque will be less. Having calculated the torque the pitch at any point can be calculated from equation 8, substituting the appropriate value of x. It will be seen that the pitch will vary lineally with distance along the rope, which is what is found in practice apart from end effects.

The above formulae were first derived in 1952 after studying the experimental results reported by Layland *et al.* (*op. cit.*) and were published in a contribution to their paper. In a table in that contribution

[1] LAYLAND, C. L., RAO, A.R.S., and RAMSDALE, H. A. Experimental investigation of torsion in stranded mining wire ropes. Institution of Mechanical Engineers, *IB*, 1952–3, 323.

(Table 23) the torques and pitches of Gifford's ropes were calculated for various conditions. The pitches agreed quite closely with those obtained with ropes previously used, bearing in mind the swivelling procedure which had been adopted in each case, but at that time no measurements whatever had been made of torque in the ropes and all the calculations were based on values of a and P_o arrived at empirically.

The author mentions on p. 14 that it was recognized that best results would be obtained by swivelling at 70 level ; one of the reasons why this was not done—for example, with the sixth pair of ropes—was the fear that the torque might be so high that it would exceed the safety limit of the controlled swivel. In 1952, using the above formulae, the torque with no twist released from the rope was predicted as 575 lb.-ft. and, owing to the empirical constants used for the rope characteristics, the maximum likely error was given as $\pm$ 30%. In fact, when this procedure was tried with the seventh pair of ropes, the maximum torques before release of twist were 520 and 540 lb.-ft. and the error in the original estimate was less than 10%.

Using the formulae derived above, the behaviour of a rope—the torque and lay pitch at each end—can be accurately predicted for any combination of load and release of twist. The characteristics of the seventh (current) pair of ropes are shown in Fig. 13 ; the data from which these graphs were prepared are given in Table 7.

These graphs show a number of points of interest. The rope constants, a and P_o, were calculated from the readings of torque and pitch when the ropes were installed. P_o, the pitch at which the (unloaded) rope would exert no torque is 15·1 in. This is higher than the pitch to which the rope was originally laid up, which is given in the paper as 14·4 in. or 14·5 in. (Appendices), but which by calculation appears to have been 14·74 in. The difference between P_o and the original pitch (0·36 in.) is a measure of the extent to which the rope was not " dead " as manufactured.

In Fig. 13, the torque is indicated for three conditions :—

A.—With the cage on the keps at 70 level ; only the weight of the chains is on the rope.

B.—With an empty cage.

C.—With a fully-loaded cage.

For each of these conditions the pitches at the sheave end of the rope and at the cappel are also shown.

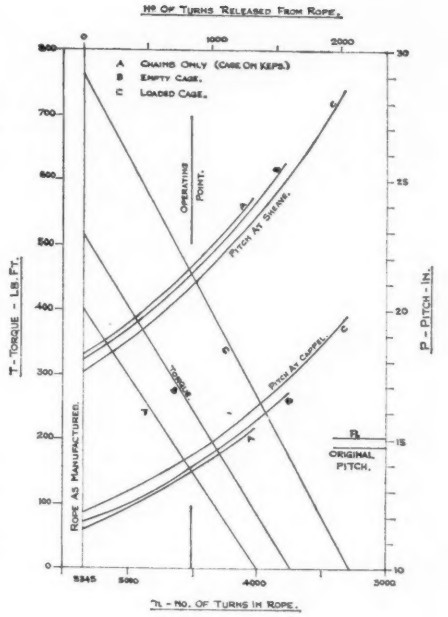


Fig. 13

If no twist was released from the rope Fig. 13 indicates that with an empty cage (*B*) the torque would be 520 lb.-ft. and the pitch at the sheave 18·0 in. The actual torques measured were 520 lb.-ft. and 540 lb.-ft. and the pitches were 17·77 in. and 17·0 in. The last figure is anomalous, probably due to end effects.

When the ropes were installed approximately 830 turns were released, bringing the total down to 4,540 turns. This operating point is indicated in Fig. 10. With an empty cage the torque is 250 lb.-ft. which was the controlling factor in determining the number of turns to be released. When the cage is rested on the keps the torque falls to 150 lb.-ft. and it is only this torque which tends to twist the chains. On the other hand, with a fully-loaded cage being hoisted, the torque rises to 455 lb.-ft. These changes in torque are also accompanied by changes in

Table 6

	a	P_o — in
Fifth Pair	27,500	15·4
Sixth pair—West Rope	23,000	17·6
—East Rope	26,200	17·6
Seventh pair—West Rope	36,400	15·07
East Rope	34,800	15·14

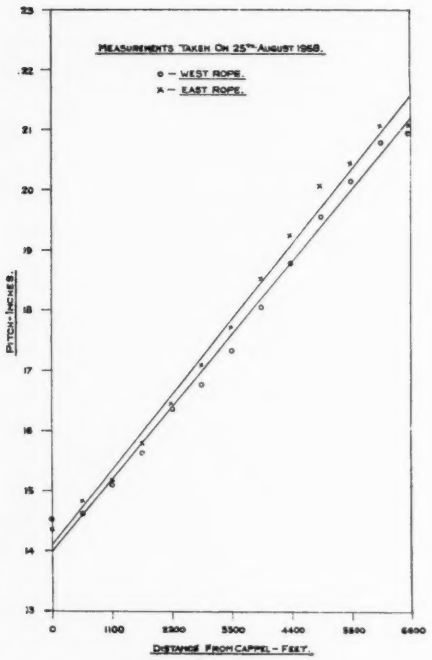


Fig. 14

pitch at each end of the rope. In lifting a full cage off the keps the pitch at the sheave end should shorten from 21·7 in. to 20·8 in. and that at the cappel lengthen from 13·8 in. to 14·4 in. It is possible that, due to internal friction in the rope, the full change does not take place on each wind, but some change occurs and accounts for the observed phenomena of the rope rotating at the beginning and end of each wind.

Fig. 13 also shows the conditions obtaining if different numbers of turns had been released from the rope. These curves are probably fairly typical of any of the ropes which have been used in Gifford shaft. However, the characteristics of different ropes may vary sufficiently to have an appreciable effect. For example, the sixth pair of ropes gave a calculated P_o of 17·6 in. and the original pitch was 14·7 in. This P_o is 2·5 in. higher than for the seventh pair. It resulted in higher torques and more turns released (1,060) to reduce the torque to a manageable figure. Even then it was thought that the torque with an empty cage was still over 300 lb. ft.

In conclusion, the rope characteristics of the last three sets of ropes, calculated from tests made in the shaft, were as shown in Table 6.

Table 7

Data for Seventh Pair of Gifford's Ropes

Suspended load, W_s :—

(A) Chains only	1,800 lb.
(B) Empty cage	8,100 lb.
(C) Loaded cage	21,100 lb.
Weight of suspended rope	39,810 lb.
w	0·506 lb. per in.
R 0·63 in.	
R' 0·82 in.	
a 35,000 lb. ft.^{2}	Obtained from torque and
P' 15·1 in.	pitches at installation.
Original n 5·345 turns	
(Equivalent pitch 14·74 in.)	

For calculating a and P_o, the following data were used :—

	West Rope	*East Rope*
Torque with empty cage—lb./ft.	259	244
Pitch at sheave end—in.	21·12	21·54
Pitch at cappel—in.	14·02	14·10

The pitches are taken from the best straight lines through the curves of pitch v. depth in Fig. 14, from measurements on August 25, 1958.

Shipping Sulphur in Liquid Form

In the August issue of the MAGAZINE a correspondent described the manner in which sulphur mined in the Gulf of Mexico by the Frasch hot-water process is now being transported in liquid form. A recent communication from the **Fairbanks Whitney Corporation,** of New York, shows how this method has been facilitated by the introduction of specially-designed pumps capable of handling sulphur in its molten state heated to a temperature of 275° F. The liquid chemical, it is stated, is pumped directly from heated shore tanks into the cargo vessel in a fraction of the time normally required to handle a solid shipment.

The first ocean-going tanker devoted exclusively to the transportation of molten sulphur, the S.S. *Marine Sulphur Queen*, went into service earlier this year and is now delivering cargoes from the Texas Sulphur Company plant in Beaumont, Texas, to molten sulphur terminals at Tampa, Florida ; Norfolk, Virginia, and Carteret, New Jersey. Owned by Marine Transport Lines, Inc., of New York, the 523-ft. tanker can carry 15,100 tons of molten sulphur in special steam-heated tanks. Before being converted she was the oil tanker *Esso New Haven*.

Eight vertical turbine pumps designed by Fairbanks, Morse, and Co., the largest industrial subsidiary of the Fairbanks Whitney Corporation, lift the hot cargo up out of four shipboard tanks and transfer the liquid to storage facilities on shore. Each of the 10-in. four-stage pumps being used has a rating of 650 gal. per min. against a 140-ft. total dynamic head. The bowl assembly, disconnect box, discharge column, and discharge head are completely steam-jacketed to maintain the sulphur at its proper temperature. In other respects construction of the pumps is standard cast iron, carbon steel, with stainless steel bolting. The bearings are soft cast iron, lubricated by the liquid sulphur.

Europe's Largest Ilmenite Mine in Production

J. Grindrod

Operations at the Tellnes Mine in Norway are described.

Officially inaugurated on October 16, 1960, what is claimed to be Europe's largest ilmenite mine, operated by Titania A/S, a subsidiary of the National Lead Company of New York, is now in production at Tellnes, in south-west Norway, yielding some 2,000 tons of ore a day with an 18% TiO_2 content. By various stages of concentration the titanium oxide content is being increased to 44% to 45%, at which strength the concentrate is shipped abroad, particularly to Western Germany.

Located near its sister Sandbekk-Sokndal ilmenite mine, which has been operated by underground methods for many years and from which production will be gradually reduced, the new Tellnes operation is in rugged country and its orebody outcrop lies

Air Survey over the Tellnes Area.

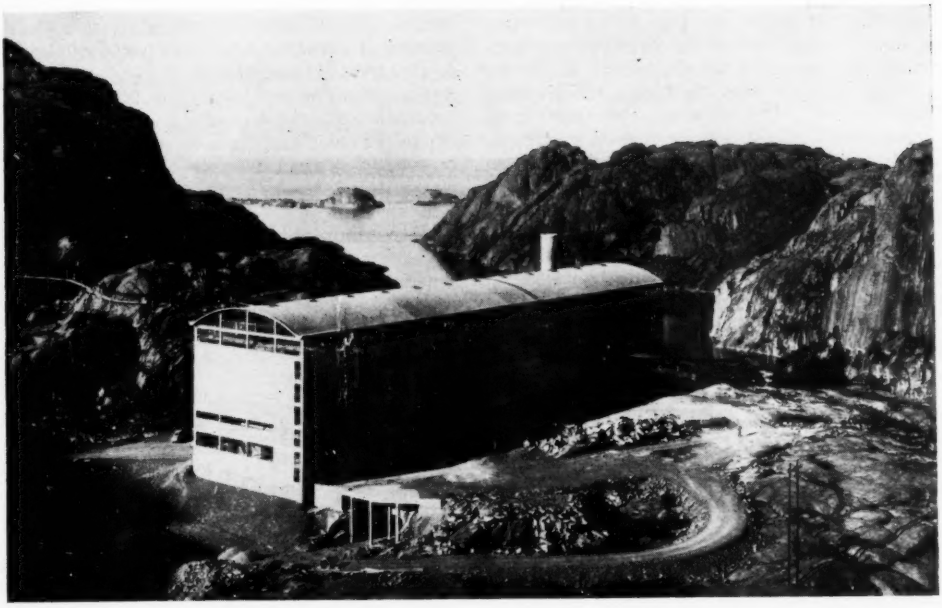
Construction Begins at Tellnes.

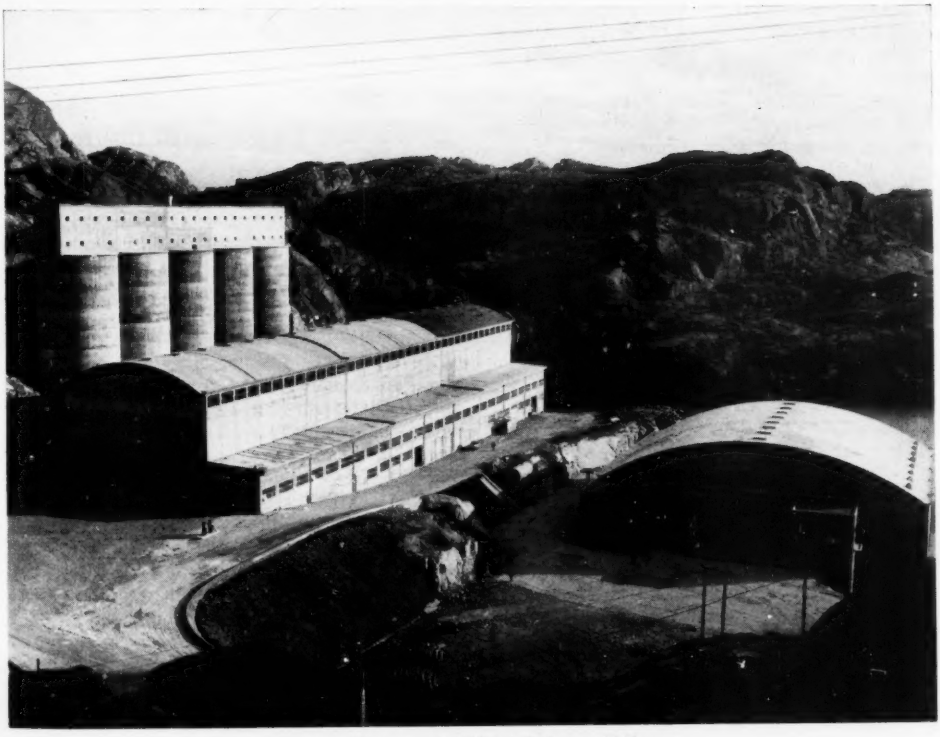
at about 750 ft. above sea-level. Containing an estimated 350,000,000 tons of ore, the deposit is mostly covered with a 30-ft. overburden consisting of clay, silt, peat, or moss. Much of it, however, lies under Tellnes Lake, part of which will have to be drained. Mining is at present being carried out by opencast methods and the concentrate is being delivered in slurry form to Joessingfjord, 2½ miles away, by underground pipeline, for which a tunnel has been cut. Another 3-mile-long tunnel, at a lower elevation, has also been driven between the opencast mine and Joessingfjord for the purpose of draining the pit and subsequently for taking drainage water from a part of the Tellnes Lake, which has been enclosed by a dam constructed across its width, to the sea. This latter tunnel will also be used for the gravity conveyance of flotation tailing for dumping in the fjord; both the tunnels have a gradient of 2%. From the shorter, concentrate, tunnel the pipelines emerge to be carried the remaining distance to the drying plant on trestles.

Discovered in 1954–55 by an aeromagnetic survey conducted by Hunting Geophysics, Ltd.,[1] and later proved by diamond drilling, the Tellnes orebody consists of a huge ilmenonorite deposit with an outcrop of 1·6 miles in length and an average width of 600 ft. The ore is fine grained and very homogeneous, containing about 39% ilmenite and yielding 18% TiO_2, with 2% magnetite and small amounts of sulphides and apatite. Outstanding among the gangue minerals are plagioclase feldspar and hypersthene.

At the pit the overburden is being removed by sluicing and the ore is being drilled for blasting by two Ingersoll-Rand Crawl-IR drills. Each blast-hole, 3½ in. in diameter and 50 ft. deep, is intended to release an average of 400 tons of ore, which is loaded by 4½-cu. yd. Ruston-Bucyrus shovels into German Faun 20-ton end-dump trucks for delivery to the 42-in. Allis-Chalmers "Hydroset" gyratory crusher at the pit site. From

[1] See THE MINING MAGAZINE, Jan., 1956.





Drying Plant and Mill Buildings, Tellnes.

the 100-ton surge bin associated with this coarse crusher the ore is delivered by conveyor-belt to the top of the five main ore storage bins at the crushing and grinding plant which is located a short distance from the pit itself.

From the ore storage bins the ore is taken to a 5½-ft. Symons Standard secondary cone-crusher and a Shorthead tertiary cone-crusher and so to a Swedish Lindberg non-binding vibrating screen, the rejects from which are recycled to the tertiary crusher.

Material accepted by the Lindberg screen passes forward to the grinding mill bin and thence to ball-mills, arranged in closed circuit with 20-in. Krebs hydrocyclones, where it is pulverized into a fine mixture of ore and water.

From the hydrocyclones the flow passes to Thune magnetic drum separators with counter-current tailing motion, the coarse magnetite concentrate being later reground and treated in another set of Thune separators to give the final magnetite concentrate. This is sent by pipeline through the concentrate tunnel to the drying plant at Joessingfjord, where after being filtered it is stored in underground bins pending shipment.

The tailings from both the magnetic separators go through a two-stage desliming process by hydrocyclones, while the underflow is passed forward to a four-stage flotation process, involving 48-in. Galigher " Agitair " cells, which had been worked out in a pilot plant after a considerable amount of laboratory development work. In this process the pulp is deslimed and then conditioned at 70% solids with a tall oil—fuel oil emulsion. Sodium fluoride is added during the first conditioning stage to depress the apatite and the rougher concentrate is then cleaned three times, reconditioning being carried out in special conditioners before each of these stages. In the second cleaner stage hydrofluorsilicic acid is used as the depressant for the apatite.

Following cleaning the end product containing 44% to 45% TiO_2 ilmenite concentrate is delivered by pipeline through the concentrate tunnel. In order to reduce the phosphorus and sulphur content of concentrate it is thickened and leached with dilute sulphuric acid. This takes the apatite into solution and that is withdrawn, while the sulphides are floated from the acid pulp in rubber-lined Galigher Agitair flotation cells. The concentrate itself passes through disc filters, following which it is dried in a Ruggles-Coles dryer before being dropped the 500 ft. to fjord level and stored in an underground silo which is 400 ft. deep and will hold 50,000 tons of concentrate.

The magnetic separation and flotation concentrating plants can deal with 1,000,000 tons of ore per year and have an annual capacity of 300,000 tons of ilmenite concentrates and 22,000 tons of magnetite. Developments at Tellnes and Joessingfjord are estimated to have cost more than Nor. Kr. 75,000,000 (over £3,500,000). All the buildings at the concentrating plant are constructed of reinforced concrete and have no supporting columns.

As well as winning and concentrating the ilmenite ore, Titania A/S is also responsible for its shipment, after processing, from Joessingfjord.

It is understood that a method is under development for producing an ilmenite concentrate with a 70% to 75% titanium oxide content. The new process is also understood to yield a high-grade metallic iron concentrate which could be used directly in steel furnaces.

The possibility of establishing a titanium oxide industry in Norway in the future is also being considered as well as the possibility of manufacturing titanium metal, although both these projects would call for the outlay of a large amount of capital.

Lead-Zinc Deposits of the Ruhr

The third part of the well-known Monograph on the lead-zinc occurrences in the Ruhr district of Germany has recently been published.[1] The first part of this important work, which appeared in 1951, dealt, after a general introduction, with the Auguste-Victoria mine, while the second (1958) covered the Christian Levin lead lode, discovered in 1937. The present volume, equally as comprehensive as the first two, deals not only with matters already touched upon but with the Klaren lode in Gladbeck, the southern area of the lead-zinc ore veins, the mineralization of the Julia-Constantin disturbance, the Ewald-Hannibal fault, and the Primus, as well as a description of the numerous smaller indications of the Ruhr district.

[1] PILGER, A., and others. " Die Blei-Zink—Erzvorkommen des Ruhrgebietes und Seiner Umrandung." Monographs of the German Lead-Zinc Deposits, Vol. I, part 3 :—The Lead-Zinc Occurrences of the Ruhr District and Its Border. Cloth, large octavo, 385 pages, illustrated, with 20 plates. Price 48 DM. Clausthal-Zellerfeld : GDMB.

The lodes and almost all the lode-mineral indications of the Ruhr lead-zinc field occur in disturbances of the sedimentaries, preponderating in the middle Coal Measures. The predominating ore structure is the " Breccia Ore " with gangue fragments, mostly schistose sandstone, cemented with ore. The mineralization is primary-hydrothermal, the associated plutonics occurring 4,000 m. to 5,000 m. below in the Caledonian (Brabanter) basement rocks. It is considered that the lode mineralization of the district forms a uniform succession from higher to lower thermal separation—*i.e.*, from weak mesothermal conditions about 250° C. to epithermal under 100° C. The simple succession, according to the author, runs: Quartz with sulphides and ankerite-siderite—zinc blende—copper pyrites — galena — barytes — marcasite — calcite. In some cases faults, as well as cross-cutting and diagonal sheering, cut into the succession, resulting in further upheavals and rejuvenation. The ore minerals occurring in quantitatively important amounts include zinc blende, galena, copper pyrites, and FeS_2 as pyrite or marcasite. There are also subordinate ankerite and siderite.

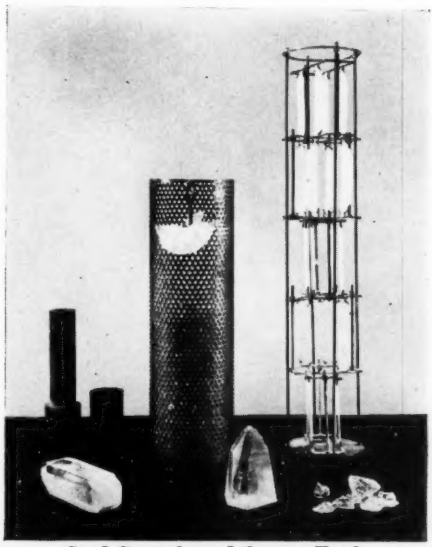
Quartz Crystals Mass Produced

Manufacture at a works in the United States described

J. A. Edwards

What is thought to be the world's first factory built to mass-produce quartz crystals for communications purposes went into production on a commercial basis at the end of 1960 at the Merrimack Valley Works of the Western Electric Company. Such crystals are used in radio and television transmitters, telephone communications, radar, and sonar. Previously the main source for them has been the interior of Brazil, where mining of the fist-sized crystals required for communications is done by individuals on a free-lance basis, resulting in unstable supplies and high prices.

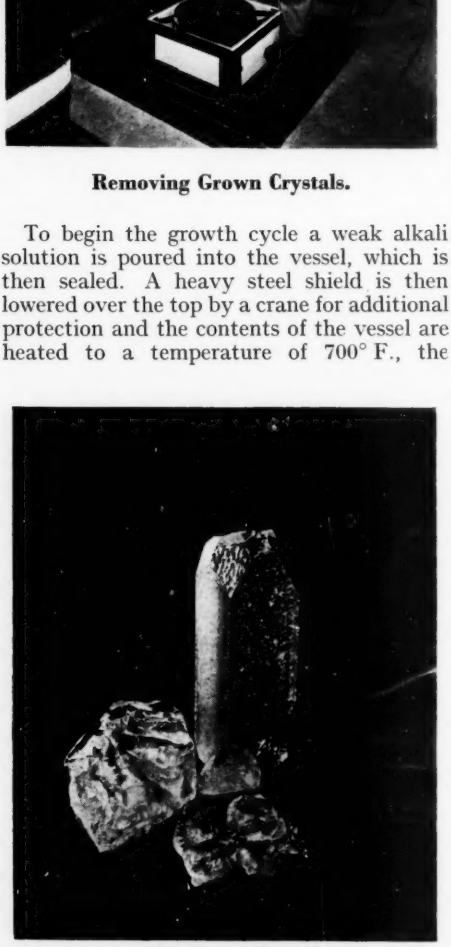
A single-story building houses the new plant, which contains both a growing area and a cutting room where the artificial crystals are sliced into wafers. This is the first step in fabricating crystals to the precise sizes required for communications uses. Subsequent operations are performed eleswhere in the works. In the growing area 20 cylindrical vessels, each about 10 ft. long and 1 ft. in diameter, are sunk below the surface of the floor. Into each vessel is lowered a long wire basket, " seed " crystals of natural or artificial quartz being suspended in tiers at the top of the basket. The lower half of the basket is filled with small inexpensive pieces of natural quartz. In this form quartz is readily available from many sources although unsuitable for communications purposes.



Seed Crystals and Quartz Feed.

Removing Grown Crystals.

To begin the growth cycle a weak alkali solution is poured into the vessel, which is then sealed. A heavy steel shield is then lowered over the top by a crane for additional protection and the contents of the vessel are heated to a temperature of 700° F., the interior pressure reaching about 25,000 lb. per sq. in. It takes about three weeks of continuous growth to produce a harvest of crystals. Under heat and pressure the small pieces of quartz at the bottom of the basket dissolve into the alkali solution, quartz being redeposited from solution and slowly built up on the "seed" plates at the top of the basket, where the temperature is slightly cooler.



Specimen Crystal.

While quartz in a variety of forms is one of the world's most common minerals, the pure colourless crystals required for communications cost about $30 a pound in the natural state. Imperfections are found even in the best of natural crystals and waste from slicing operations result in a loss of about 97% of the material. This brings the cost of the quartz in the final plates used for electronic purposes to about $94 an oz. ($1,500 a pound). Only three technicians are required to operate the new factory's growing area, which is automatically controlled except for loading and unloading the crystal-growing vessels.

While scientists have been attacking the problem of making suitable crystals for half a century it was only a few years ago that the hydrothermal process for making them was developed by Bell Telephone Laboratories. The achievement followed several years of research and experimentation after World War II. In 1958 a pilot plant for converting the laboratory process to commercial production was established at the Merrimack Valley Works of Western Electric, the Bell System's manufacturing and supply company, although much additional development work had still to be undertaken.

Not only does the Bell System's hydrothermal process for growing artificial crystals cost but a fraction of the price of natural crystals, but the artificial variety contains fewer imperfections. Dimensions can be controlled and much more of each crystal is usable. In telephone work quartz crystals are at the heart of equipment that permits many different telephone conversations to be carried simultaneously over the same circuit without interference. Quartz can also be used to regulate radio frequencies and as source of ultrasonic waves. With reduced cost of crystals there is a possibility that the gem-like crystals may find still wider application as substitutes for other elements in electronic circuits.

Non-Explosive Rock Breaking

In a recent announcement the United States General Electric Company has given some details of a new non-explosive method of breaking up rock with radio frequency electrical power which, it is claimed, can make secondary blasting and explosive-breaking as much as 25 times more economical for the mining industry. Test reports made by the company, which studied the process in co-operation with the Montana School of Mines under a research grant from the Anaconda Company, describe the process as " electrothermal forcing " and say that it can be applied without danger to workers and without interrupting working operations. The company is now able to supply rock-breaking systems operating on the new principle.

Electrothermal forcing, the report states, accomplishes power breaking in times ranging from seconds to a few minutes (depending on rock size and the method of applying power). In the process electrodes are clamped to the rock and connected to a source of high-energy radio-frequency (r-f) power which creates a current-conducting path through water trapped in the crystalline structure of the rock and comprising up to 5% of its bulk. Once established, this channel greatly decreases the internal resistivity of the rock, making it possible to pass high-energy direct-current power through the rock between the electrodes. The resulting heat, or " thermal stress," is sufficient to split the rock along the path of conductivity. Although less force is required to break metal-bearing ores because of their lower initial resistance, the process will also work with hard rock such as granite and with rock materials normally considered non-conductors. The forces applied can be controlled simply to crack, break into pieces, or even shatter the rock. Economies of speed and simplicity are expected to make the process five to six times cheaper than secondary breaking with explosives in underground mining and 20 to 25 times cheaper than secondary blasting in opencast mining.

To provide a commercial rock-breaking system on the electrothermal forcing principle the company estimates that a source of r-f current in the 20–40 megacycle range and about 25 kW of power will be sufficient. Comparable sources of current are at present available, for instance, in transmitters now being produced. High-energy impulses of power could be generated either by capacitor banks in parallel or by an impulse generator. Commercial models of this equipment are expected to sell for less than $60,000 (about £21,400).

Ore-Dressing Notes

(13) *Control.*

Sample Reduction at Kiruna

Although the method of sample reduction described here has been developed in connexion with mining as well as with beneficiation, it should have considerable interest for all mill men. The iron mine at Kiruna, in north Sweden, has ore which varies in its phosphorus content between 0·017% and over 2% and this must be controlled in the finished product. Some 70% of the shipments are of blast-furnace ore averaging 1·6% P, while open-hearth ore must be below 0·1% P and there are other specifications to be met. About 1,000 samples must be assayed daily, and for this purpose the present plant was designed in 1957 and brought into use in 1959. As considerable expansion is expected provision has been made for a large increase in handling capacity. Following statistical studies, it was decided to take 1 kg. weight as representative of a carload lot, or of the ore from one round of shots. For some ore grades five samples are combined, so that the plant can handle either 1 kg. or 5 kg. entries. Twenty process lines are in use and a sample moves by gravity through three floors of the building during its preparation. At the top is a drum drier, a gyratory crusher and automatic splitter follow on the intermediate floor and the final stage is a mortar grinder and sample box on the bottom floor. The entering sample is poured into an available drum, its tag number being transferred to a holder in the final sample container cover, which is then dropped into a chute paralleling the process line and sent to await arrival of the product. The operator now pushes the starting button and the rest of the work is done automatically. The drum moves to a horizontal position and begins to rotate at the same time that its heating elements warm up. After 6 min. at 130° C., up to which temperature the pyrite in the ore is not affected, the drum empties and the gyratory crusher, splitter, and mortar grinder start up.

A strong blast of air sweeps the drum clean and it returns to its "ready" position for another sample. Work on this can start at once without risk as an automatic catch prevents the drum from emptying until the equipment on the floor below is clear of the previous load. The miniature gyratory crusher delivers to a rotary disc splitter which rejects 90% of the feed and drops the retained portion to the mechanized mortar for finishing. Grinding and splitting are continuous and usually take some 3 min. For larger samples two splitters operate in series. From an aperture at the bottom of the mortar the final sample is discharged to its container, the identifying cover is placed on it, and it goes to the laboratory. The sections are then cleaned for 15 sec. with an air blast. The plant has proved reliable and most satisfactory.[1]

(14) *Roasting.*

A Refractory Gold Ore (2)

The roaster designed to fulfil the requirements of the antimonial ore already described has two separate reactors connected by a transfer cyclone, the first fluid bed being inside a 16 ft. brick-lined column set 5 ft. above the second reactor of 14 ft. diameter. About 195 dry tons of flotation concentrate are pumped in as a slurry with 76% solids. The departing calcine is moved *via* a U-tube which has a small air jet at the bottom to help lift the material, which then enters the second reactor at bed level, the transfer cyclone cleaning the dust-laden gases. Temperatures in both stages are controlled by water injection operated manually and each stage is monitored by four thermocouples.

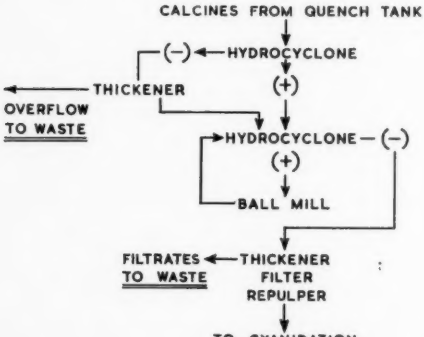


Fig. 2.

The roaster started work in November, 1958, with 1,100° F. temperature in the first stage and 1,300° F. in the second. These were gradually lowered, keeping a small excess of oxygen in the first reactor, until the present best results were reached. The bed temperature in the first roast is now held at 925° F., with the second bed at 875° F. The lower temperature at this stage is needed to moderate the roasting of fine material in its oxygen-rich atmosphere, which reduces extraction efficiency. Oxygen flue gas in the first stage is ideally between 0·2% and 0·5%.

There have been teething troubles, mainly traced to feeding methods and feed preparation. At these lowered temperatures the roaster is more sensitive to feed density, sulphur content, and rate of pumping. Figures from the cyanide section for December, 1959, showed laboratory extraction from the calcines of 93·55% and for the plant of 93·7%, total dusting losses averaging some 5½% of the gold in the roaster feed. This dust carries about 3 oz. of gold per ton, 4% arsenic, and over 5% antimony, and research for its recovery is being pressed.

The quenched roaster calcines were originally dewatered in a thickener, the underflow of which was filtered and ground in cyanide. Laboratory tests showed that low-temperature calcines needed copious washing, preferably with a preliminary grind in fresh water, the present arrangement being shown in Fig. 2. The problem of filtering a small tonnage of sticky calcine was met by recirculating part of the repulped discharge into the filter boot. The effect of this wash treatment has been to reduce cyanide consumption in the calcine treatment from 1·82 lb. to 0·83 lb. per ton. Refining difficulties have disappeared, initial extraction rates remain high, and solutions are clean. An original weakness was that high-grade solutions remained in contact with solids too long, leading to reprecipitation of some gold. Up to 50% of the gold in this calcine can be dissolved by simple percolation in less than a minute and as a consequence loss through the thickener underflow which dealt with the cyclone discharge was excessive. In the new arrangement the repulped calcine from Fig. 2 is filtered in cyanide and the filtrate goes straight to precipitation, about 70% of the gold being removed at this stage. The general grade of pregnant solution has also been lowered by increasing the handling capacity

[1] ERIKSSON, S., and SUNDSTROM, Y. *World Mining*, August, 1961.

and about 4,000 tons of solution are now precipitated daily. There is still some evidence of occasional reprecipitation and further capacity of solution treatment is planned. " Pregs " now assay 0·16 oz. per ton and " barrens " 0·0003 oz. per ton. Loss of soluble gold entering the plant is 0·1%.

(15) *Testing.*

An Iron Ore Pilot Plant

In connexion with the investment of $200,000,000 at Wabash Lake in Labrador it was felt essential [1] to make thorough tests of the concentrating characteristics of the ore-body before proceeding with the large-scale design of the treatment plant. The material includes medium-grained specularite, granular quartz, earthy iron oxides, martite, and fine magnetite. Manganese occurs as pyrolusite and psilomelane, with some manganite. Preliminary tests showed that the ore breaks readily to the natural quartz grain size and that a high-grade product can be made with *minus* 28-mesh grinding, or a very good concentrate by magnetic concentration after grinding to *minus* 100 mesh. Manganese content can be lowered by flotation.

Since the ore is free-milling autogenous grinding was chosen, the relative simplicity of wet grinding leading to its choice rather than a dry method. As liberation at *minus* 28 mesh needed investigation and air classification had shown good results in preliminary work, the autogenous mill was equipped to test both systems. For dry sizing of the discharge from the 10 ft. by 3 ft. mill three stages of air classification are used. In the first, heavier particles drop back to the mill as discharge velocity falls through the expanding discharge section. Next comes an air cyclone and finally a wet dust collector. Intake air is preheated so as to reduce ore moisture below 1½%. Wet sizing methods tested included those with mechanical and hydraulic classifiers, cyclones, and mechanical screens. The last named gave best promise and were incorporated in the wet-grinding closed circuit. Humphreys spirals with either two or three treatment stages were indicated for gravity treatment coupled with magnetic separation. Laboratory tests suggest that spiral tailings should be sized at *plus* and *minus* 100 mesh in cyclones, the overflow being passed to magnetic separation.

Owing to the presence of limonite and other earthy minerals and slimes in the ore flotation at the primary stage is not practicable, but might prove useful in treating the gravity concentrates to float specular hematite away from the manganese-rich minerals. As the final concentrates must be railed they are filtered to reduce moisture to some 4%, internal drums or top-feed being indicated because of the rapid settling rate of the materials. The machine selected for the pilot plant is top-feed, with preheated air. A single disc filter is separately provided for the fine magnetite concentrates, produced intermittently.

The pilot plant started up in February, 1960, under freezing conditions, which limited work with the dry grinding unit. Wet grinding was substituted after three weeks and found preferable. Power consumption has been very low, at 2·4 kWh. per ton of *minus* 8-in. feed, due largely to the weakly-bonded nature of the ore. Spirals have performed consistently and well, despite wide fluctuations of feed grade. The top-feed filter also does a good job and can at need reduce moisture to 1½%, although a shipping figure of 4% has proved satisfactory, with negligible freezing *en route*. The flotation system, using oleic acid as collector, brings the float to *minus* 0·2% Mn. Over 40,000 tons of concentrate were shipped during 1960 for sintering and blast-furnace tests. When this paper [1] was published work was still incomplete, one matter under investigation being the possibility of producing ultra-high-grade concentrates suitable for direct reduction to iron.

Book Reviews

Minerals for the Chemical and Allied Industries. By SYDNEY J. JOHNSTONE and MARGERY G. JOHNSTONE. Second edition. Cloth, octavo, 788 pages. Price 147s. London : Chapman and Hall.

A reference book to be useful must be kept reasonably up to date. This is the second edition of a book published originally in 1954 and reviewed in the October number of the MAGAZINE for that year. Over the years the first edition has proved to be an outstandingly valuable source of information, but a new edition was certainly due and is most welcome.

This edition is considerably longer than the

[1] MERKLIN, K. E., and DEVANEY, F. D. *Engg. Min. J.*, April, 1961.

first, having not only more pages but, due to a different and more attractive format, each page contains more information. New chapters have been added on diamond, gold, hafnium, helium, scandium, and yttrium. Chapters on iron ore and clay replace those on hematite and china clay in the earlier edition. Apart from these new chapters it is interesting to note which of the other minerals have received considerably more attention in the present edition as compared to the first. Thorium and the rare earths, silica, tripoli, and pumice, aluminium, chromium, and zinc are some of the minerals and groups of minerals which receive expanded treatment in this edition. Expansion in the various chapters has taken place mainly in dealing with the uses of the materials concerned.

The numerous tables of production statistics in this book now contain figures for the years up to and including 1958. Since the first edition was published much information has been released from Government files and this is incorporated. The authors have wisely retained many of the specifications for the United States National Stockpile, although stockpile purchasing in that country is not now so prevalent. The authors have taken note of the minor criticisms in the reviews of the earlier edition and have corrected the mis-statements which were commented upon. The references at the end of each mineral section and the general references have been brought up-to-date and include works published in 1960; these references form an invaluable part of the volume.

There is no doubt in the reviewer's mind that this book will be an important addition to the bookshelves of members of the mining profession. It contains within its covers information which is not otherwise easily accessible. It is particularly useful in giving information about industrial and other "bread and butter" minerals, which so often have been neglected by mining engineers, geologists, and companies as being beneath their dignity.

W. J. YUILL.

Quin's Metal Handbook, 1960 edition. Cloth, pocket size, 648 pages. Price 35s. London: Metal Information Bureau, Ltd.

The new issue of "Quin's Metal Handbook" is the 46th edition of this useful work of reference. As usual it contains a vast amount of information relating to prices, production, consumption, exports, imports, destinations and sources, brands and stocks of non-ferrous metals, ores, scrap, iron and steel, ferro-alloys, tinplates, blackplates, galvanized sheets, etc., relating to all major countries.

Well indexed, quick and easy reference to any metal in any part of the world is readily obtainable and, as usual, every endeavour has been made by the publishers to make the volume comprehensive. It has been completely revised, while extracts relating to the exports and imports of ferrous and non-ferrous metals for the Soviet Union are again included, covering the years 1958 and 1959.

☛ Copies of the books, etc., mentioned under the heading "Book Reviews" can be obtained through the Technical Bookshop of *The Mining Magazine*, 482, Salisbury House, London, E.C.2.

Engineering Log

In July Canada's largest processing plant for natural gas was opened in Alberta and began to work up towards processing its 326,000,000 cu. ft. per day of raw gas from a $12,500,000 investment. This partnership of 27 petroleum companies is already under contract to supply 170,000,000 ft. of gas daily to America's midwest and as far east as Montreal, beside 110,000,000 ft. to the Pacific Coast area. From its 326,000,000 ft. of input the yield will include 280,000,000 ft. of gas for industrial and domestic use, 86,000 gallons of propane, 112,000 gallons of butane, 12,600 gallons of petrol, and 250 long tons of sulphur. Construction began in February, 1960, and sales of gas began last January. The plant draws from two fields developed since 1953 with proved reserves of 2,200,000 million ft. of saleable gas, but this is less than one-tenth of Alberta's proved reserves. The Dick Lake gas field extends north of the gas plant at Rimbey and three of its ten successful wells produce over 60,000,000 ft. of gas each on test. South from Rimbey is the Homeglen-Rimbey field with its known 1,000,000 million ft. reserves of raw gas. Oil also underlies the gas cap, 529 ft. thick at its deepest point, and it has currently 34 producing oil wells. To the long-established grain, dairy, and livestock farming in the region will now be added the secondary chemical industries made possible by this abundant by-product

supply of sulphur, propane, and butane. Among other novel features the Rimbey plant is the first in Canada to use outdoor type construction and centrifugal compressors.

* * *

The magnitude of the revolution in industrial practice which is proceeding all over the world through the increased use of computers is of such importance that it has created a new literature which, whether liked or not, must be understood to some extent. Figures released on the eve of the October Business Efficiency Exhibition show that despite a slow and shaky start several hundred installations are now at work in Britain and more are on order. When facts are produced anywhere in an organization the more quickly they are correlated, digested, and presented in study form, giving relevant information on cost, production, and disposal, the surer will be the harmonizing managerial control from source to finish. This, of course, is only the starting point. As soon as techniques had been sufficiently perfected and computers made adequately robust it was obvious that they would duly take over part control. This is happening in many industries and the improvement in results is marked. In mining some of the things which can now be done better by the aid of computers than by other known means are the maintenance of optimum capacity and the maximum profitable exploitation of the orebody in terms of change of metal prices. Milling and mining efficiency and cost, calculations of ore reserves and such matters are now brought to computer language levels and dealt with in minutes instead of weeks. A computer can monitor the mathematical model of an orebody and calculate the economic limits of open-pit extraction, bench layouts, balancing of deployment of equipment, and prediction of optimum mining methods. It can keep track of costs of various mining methods, stoping attacks, etc., and correlate them with ore grades and metal prices. It can provide any required degree of automation for many crushing, grinding, and treatment processes in the mill and go a long way toward maintaining continuous optimum performance in the treatment circuits. Its main purpose, however, is to give management rapid information on which accurate decisions and policies can be based. The modern computer can do up to nearly a million additions or subtractions in a second and will in future only be limited to about a tenth of the speed of electricity, using known techniques. It can increasingly make statistical decisions based on the data fed in, which compare favourably with those reached by human thinking only. This is not to suggest that the computer can think for itself. It is at the mercy of the data it receives and of the planning system which uses such data. "If you ask a silly question, you'll get a silly answer." It can select information, store it, and bring it out when wanted. It can take problems and translate them into instructions. It can deal with more than one problem at a time. One development is a Library of Programmes serving as a central point. Two such centres are at work in the U.S.A. (for roads and the Bureau of Mines). This is possible because any problem which has once been successfully reduced to "machine language" becomes available for all similar problems. There is no need for repetition of the laborious process of setting a new programme. It is not essential for a small mine to own a computer provided it has the necessary means of getting out data. Its problem can be taken to a computer centre where time and technical aid are available. As with all comparatively new processes it is difficult to evaluate the developments which computer services promise to give to industry, but it is speeding work, eliminating waste, and mechanizing routine accountancy.

* * *

Exciting possibilities for a major advance in aircraft design are suggested by work now in hand at the Royal Aircraft Establishment at Farnborough. The emphasis at the September flying show was on VTOL (vertical take-off and landing), but the new idea (ATOL) air-cushioned take-off and landing) is not yet ready for display. Some day those concerned with the project prophesy an aeroplane which will rise a few feet from the ground, hovercraft fashion, and then glide forward as its jet engines take up their load. The concept is of marriage between the hovercraft and the jet airliner. Wheels would be done away with, acceleration improved by the elimination of ground friction, runways shortened and simplified as regards maintenance, and amphibious take-off and landing made possible. An advantage over VTOL would be that no great power is needed to come to the hovering position.

* * *

The International Development Association held its inaugural meeting on November 8, 1960. Its parent organization, the International Bank for Reconstruction and Development, or the " World Bank," was founded as the outcome of the Bretton Woods conference in July, 1944, at which the International Monetary Fund was formed. Going by the experience of pre-war international thinking it was modelled largely on the policies of private investment and banking. It lends with reasonable prospect of repayment and with the purpose of a return on investments. Loans must therefore be made for productive purposes and must bear the guarantee of the government of the country concerned. The original operating fund was about £250,000,000 and the first loan, of £30,000,000 was made to France in May, 1947. This and swiftly following loans to the Benelux countries of £89,000,000 were for essential raw materials for post-war reconstruction. When the Marshall plan came in the spring of 1948 the Bank turned to larger objectives. In March of that year it made two development loans—to Chile for power and agricultural machinery. The first loan to Asia in 1949 was to India and others were to Australia, Ethiopia, and Iraq. In 1958 lending had increased to about £250,000,000 annually and disbursements provided about a tenth of the flow of international capital to the underdeveloped countries. It is now the world's most important source of development aid. By December, 1960, it had made advances to over 600 projects through 277 loans totalling almost £2,000,000,000 in 54 countries, a pattern likely to persist. In July, 1956, the International Finance Corporation was established with funds of little over £234,000,000. Its function has been called " catalytic," since it attracts local and foreign capital into productive enterprise. By the end of September, 1960, it had invested £16,000,000 in 35 enterprises in 17 countries, while for each pound thus invested private sources had put in more than £3. Thus, over £70,000,000 had been mobilized for investment in the developing countries.[1]

* * *

On September 10 the Stalingrad power plant was declared complete and inaugurated by Mr. Khrushchev, who thus set the seal of official approval on what may be the biggest white elephant in the modern engineering world. On this day the Soviet Union's chief engineer for water power projects stated in *Pravda* that the Volga does not carry enough water to permit the plant's full use, so that the giant project is in any case stalled for some years. This heritage of Stalin's grandiose thinking is not the only legacy of its kind, as was shown by Mr. Khrushchev's admission in January that plans for an even larger water scheme at Bratsk in Siberia were mistaken and that it would have been better to have built several large water-power plants in Central Asia under more favourable climatic and economic conditions. The Stalingrad station, which has a capacity nearly twice that of the Hoover dam or almost that of all Belgium's plants put together, feeds nearby industries which can only consume a fraction of the power. One major purpose is to propel the pumps which are to irrigate huge desert-like areas in the lower Volga valley and the Caspian lowlands, a tremendous irrigation scheme including a canal between the Ural outcroppings and north Kazakhstan, part of Stalin's plan for " Transformation of Nature." It was shelved after his death because of the vast expense involved, but revived when Mr. Khrushchev switched pressure from development of the virgin lands to expansion of corn growing. In any case since the Stalingrad station cannot at present work to its installed capacity more water must be diverted into the Volga. This is to come from the Vichegda and Pechora rivers, now flowing into the White Sea, but scheduled for diversion into the Kama, a large eastern tributary of the Volga. Without this extra water the level of the landlocked Caspian Sea, which has already receded some 30 miles, would drop yet lower, doing further damage to the fishing industries already affected and impeding shipping. Nature, as ever, has the last word.

* * *

Camp Century, 800 miles from the North Pole, has now been in occupation for a year. This piece of United States construction in Greenland combines under-snow shelter with the use of nuclear power for heating and lighting. Deep trenches were first cut in the snow, using rotary ploughs. The trenches were then covered with arched sheets of corrugated metal, in its turn covered with excavated snow. When this had hardened the arches could be removed. Prefabricated buildings were placed in the tunnels to serve a permanent population of between 150 and 200. Now even the shrieking 100 miles an hour

[1] BLACK, E. R., *Horizon*, Sept. 1961.

blizzards do not disturb the sub-surface quiet or the snugness of the electrically-heated buildings. Even in midsummer the surface temperature does not rise above freezing point, but if it should provision is made for using refrigeration to maintain structural strength by air from holes drilled deep into the ice. The camp was built to test methods of construction in Arctic conditions, to try out a portable nuclear reactor, and to give a base for polar research. Thus far this scientific version of the igloo has been justified in the results obtained. New knowledge concerning movements of the ice cap which covers most of Greenland to a depth of 7,000 ft. or more, of weather conditions in past centuries, and of old volcanic activity are only part of the research which may yet reveal the reason for naming this desolate region Greenland. Ten years' occupation is hoped for before movement of the ice makes Camp Century uninhabitable.

News Letters

BRITISH COLUMBIA

October 4.

Placer Development, Ltd.—Placer Development, Ltd., earned a profit of $2,735,303 in the fiscal year ended April 30, 1961, which compares with $1,580,431 in the previous year. The company had gross revenue of $6,054,725, total disbursements by payment of dividends being 70 cents per share, as compared with 50 cents in the previous year.

The wholly-owned subsidiary, Canadian Exploration, Ltd., milled 368,545 tons of ore from the Jersey lead-zinc mine at Salmo grading 2·2% lead and 4·6% zinc and produced 9,081 tons of lead concentrate and 26,206 tons of zinc concentrate. At April 1, 1961, the ore reserves were estimated at 620,422 tons assaying 1·4% lead and 5·0% zinc. Additional ore was developed during the year but with low lead content and the management fears that the life of the mine may be limited if new reserves are not developed. The company still has a stockpile of tungsten concentrate containing approximately 37,000 units of WO_3. Canadian Exploration was also active in the exploration field during the year directly and through participation with Centennial Mines, Ltd., and Magnum Copper, Ltd. Craigmont Mines, in which Canadian Exploration holds 44·6% of the issued capital stock and has management control, commenced production in mid-September at the rate of 4,000 tons per day from reserves estimated at 22,575,000 tons grading 2·08% copper and 19·6% iron. The mine is situated in south-central British Columbia.

Canadian Exploration also holds 22·55% of the issued shares of Mattagami Lake Mines, Ltd., a Quebec company preparing for early production and smelting with ore reserves of 23,000,000 tons assaying 0·02 oz. of gold and 1·3 oz. silver per ton, with 0·7% copper and 12·7% zinc. The operating partners in the Mattagami Lake project include Noranda Mines and McIntyre Porcupine Mines, with the former providing management. Another wholly-owned subsidiary, the American Exploration and Mining Co., conducted exploration in several parts of the United States, Alaska, and the Philippine Islands. The company realized a profit of $217,445 when a major steel company exercised its option to purchase American Exploration's half interest in certain Nevada iron deposits. The Evan Jones Coal Co., in which American Exploration holds a 48⅓% interest, continued a satisfactory coal-mining project north of Anchorage, and the operator holds a contract to supply the United States Government with 130,000 tons of coal during the current year.

In New South Wales the Foybrook-Newdell operation of Clutha Development, Ltd., showed a marked improvement and sold 426,000 long tons of washed coal at a satisfactory profit. Also in Australia, Wolclift Pty. Ltd., the wholly-owned subsidiary of Canadian Exploration, had a satisfactory year as did other Placer Development interests. Sales to Australian consumers were maintained and additional contractual export sales were made to Japan.

Placer Development joined Pato Consolidated Gold Dredging in Brazilian exploration through equal ownership of Exploracao de Minerios Brasilia Limitada, a company which changed its name during the year to Mineracao Pato de Brasil, Ltda. As a result of exploratory investigation in several areas four areas were selected : Two diamond-bearing prospects are being test-pitted and drilled, a scout-drilling programme is under way on a central Brazilian river to prospect gold-bearing alluvials, and small-scale testing work is being undertaken on beryl-bearing pegmatites in eastern Brazil. Because of disappointing results Placer has terminated its agreement with the Bol-Inca Mining Corporation for further placer exploration in Bolivia.

During the fiscal year, Placer Development purchased 70,678 shares of Bulolo Gold Dredging, Ltd., at a cost of $402,810, bringing its

holdings in the New Guinea company to 195,678 shares. Although audited figures are not yet available for Bulolo covering the year ending May 31 last a net profit of $511,500, equivalent to 51 cents per share, is indicated. This compares with $822,425, or 82 cents per share, in the previous year. Dredging and sluicing results were lower, however, a condition which also applied to the output of sawn timber and veneer by South Pacific Timbers, Lae.

Pato Consolidated Gold Dredging Ltd., earned a profit of $506,143 in the year ended December 31, 1960, which compares with $564,351 in the previous year. Yardage dredged was 23,274,000, which yielded 86,222 oz. of gold, as compared with 20,579,000 cu. yd. and 102,978 oz. in 1959. Pato distributed $700,500 in dividends during its fiscal year, Placer's share being $230,000.

The parent company's balance sheet at April 30 last shows current assets of $13,837,652, against current liabilities of $2,963,337. Investments in subsidiary and other companies and funds held in escrow aggregated $9,963,785. Of the authorized capital of 3,000,000 shares of no par value 2,580,000 shares were issued. The quarterly statement for the three months ended July 31 shows the estimated consolidated profit of Placer Development, Ltd., to be $585,672, which compare with $825,723 in the same quarter of the previous year. The decrease in operating revenue is attributed partially to the current low price for lead and zinc and to reduced profits from the South Coast mines in Australia. The reduction in interest earnings is attributed to the conversion of short-term interest-bearing deposits to investments through Canadian Exploration, Ltd., in Craigmont Mines, Ltd., and in Mattagami Lake Mines, Ltd.

Yukon.—A " Silver Mining Boom " is taking shape in Yukon according to a statement by Dr. A. E. Aho, a prominent geological engineer currently engaged in south-western and west-central parts of the Territory. A parallel favourable zone, 15 miles west of the productive mines of United Keno Hill Mines is the object of present attention. Spectacular discoveries have also been made in the south-eastern section, near Watson Lake.

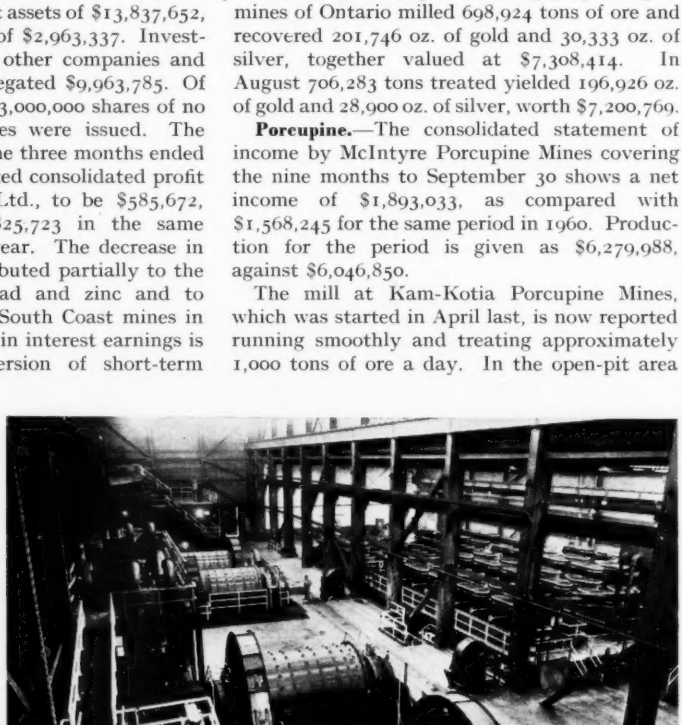
EASTERN CANADA

October 23.

Ontario Gold Output.—During July the gold mines of Ontario milled 698,924 tons of ore and recovered 201,746 oz. of gold and 30,333 oz. of silver, together valued at $7,308,414. In August 706,283 tons treated yielded 196,926 oz. of gold and 28,900 oz. of silver, worth $7,200,769.

Porcupine.—The consolidated statement of income by McIntyre Porcupine Mines covering the nine months to September 30 shows a net income of $1,893,033, as compared with $1,568,245 for the same period in 1960. Production for the period is given as $6,279,988, against $6,046,850.

The mill at Kam-Kotia Porcupine Mines, which was started in April last, is now reported running smoothly and treating approximately 1,000 tons of ore a day. In the open-pit area



Ball-Mill Aisle, Levack Mill, Sudbury.

above 200 ft. there are indicated reserves of some 1,300,000 tons containing 1·725% copper.

Kirkland Lake.—Plans for a merger between Macassa Mines, Ltd., and Bicroft Uranium Mines, Ltd., have been announced. After Macassa has disposed of its properties and plant to Bicroft the companies are to amalgamate with a new company entitled Macassa Gold Mines, Ltd.

Sudbury.—Falconbridge Nickel Mines reports earnings of $8,443,377 for the six months ended June 30 last, a figure which compares with $7,753,709 in the corresponding period of the previous year. For the first half of 1961 nickel shipments totalled 33,676,000 lb., against 32,292,000 lb. a year ago.

Manitoba.—It has been announced by the Nickel Mining and Smelting Company that construction is to be started on the mill for the Gordon Lake property in Ontario. Railhead for the operation, which lies 12 miles east of the Manitoba boundary, is at Loc du Bonnet. A power line is being erected to serve the mill, which is planned for a capacity of 700 tons a day. At the mine 825,000 tons of ore with 1·75% nickel and 0·72% copper, with $3·00 per ton of precious metals, are in reserve. Concentrates are to be treated at Inco's Copper Cliff smelter.

For the three months to June 30 last Sherritt Gordon Mines reports improved earnings equal to 8·1 cents per share. At the Fox Lake copper-zinc prospect encouraging results have been obtained by diamond drilling, copper values of 2·5% over 25 ft. width being reported. It is also announced that a urea plant to cost about $3,000,000 is to be erected at the Fort Saskatchewan refinery.

Quebec.—In the first five months of the current year Barrat Mines milled 237,053 tons of ore, recovering bullion valued at $1,024,009. The operating profit for the period is given as $196,945.

AUSTRALIA

October 20.

Coal.—Coal continues to lead all Australia's export minerals. Large orders are being received for steam coal and prospects for steam and coking coal are good. It is stressed by observers that strong competition is to be expected from United States coal which has lost ground to Australian exporters and efforts are being made to undercut Australian prices in the Japanese market.

A strong point in favour of the U.S. coal exporters is that their coal ports can handle larger ships, which gives an advantage in freight rates. To counter this trend the Commonwealth Government is to provide up to £A2,650,000 for the provision of coal-loading plant and equipment at the ports of Newcastle, Port Kembla, and Balmain. The grant will cover coal-loading plant, wharfage, storage, and associated rail facilities, but will exclude provision of deep-water berths, which will be a matter for the State Government finances. Tenders are being called for coal-handling plant to be built at the inner harbour, Port Kembla. The most suitable site for the new plant at Newcastle has not yet been decided. This plant is to have a capacity of 2,000 tons of coal per hour.

Since the decision to provide port equipment at Port Kembla the proposal to build an off-shore loading plant at the Coal Cliff colliery, 20 miles north of Port Kembla, has been deferred. Modernization of the coal ports will be an important factor in securing large long-term contracts for export coal that could exceed 4,000,000 tons per year. This potential prosperity may be threatened by industrial unrest, for the unions have now sought a 30-hour week for underground metal mines, a claim dismissed by the Commonwealth Arbitration Commission. The claim had been preceded by agitation for a 35-hour week in coal mines, but such demands are likely to be renewed and would, if granted, have a very serious effect upon export prospects.

Oil Search.—The Commonwealth Government continues its policy of assistance to companies engaged in the search for oil and the list of subsidies grows steadily. The latest statement advises grants of subsidies totalling £A41,000, including two for stratigraphic drilling and one for seismic survey. In Victoria Frome-Broken Hill's Flaxman's No. 1 well discovered gas in a 486-ft. interval between depths of 10,842 ft. and 11,528 ft.; the test was not completed. A substantial flow of hydrocarbon gas was struck in the first bore in this vicinity and drilling has been extended. The Woodside and Atlantic companies are to spud in the first bore under the agreement between the two companies on the shore of Lake Wellington, near Sale. The Woodside company, before joining forces with Atlantic, spent £A100,000 on seismic surveys in the area over a period of 12 months. Woodside (Lakes Entrance) Oil Co. and its U.S. partner propose to spend £A1,325,000 in the next three years.

The Associated Australian Oil Group, drilling in Queensland, is to be joined by the Continental Oil Co. of Australia and Ohio International of

Australia, Ltd., subsidiaries of American companies. Concentrated exploration will be carried out over 13,000 sq. miles of country on Duaringa, midway between Rockhampton and Emerald. Recent drilling in this region has been encouraging.

Gold.—Gold Mines of Kalgoorlie (Aust.) has reported that a number of rich shoots of ore has been exposed during driving in the new North Boulder–Oroya South section of the eastern leases. The shoots, which are short, are principally in the Bank of England and Ley lodes. There are also reported good developments in the Perseverance–South Kalgurli section, notably in the Golden Cellar lode and the No. 1 East Lode at No. 2 level, where high-grade ore with tellurides is frequently exposed.

At Great Western Consolidated all development outside blocks of ore already known has practically ceased and no significant additions to ore reserves can be expected. Mining of the remaining ore which is in progress and realization from plant will not meet the company's liabilities. The installed cost of the plant and buildings was £A1,788,562. The company's loss for the year to March 31 was £A185,648, and in the previous year £A198,706.

Misima Island.—Pacific Island Mines, Ltd., has been prospecting for gold on Misima Island, Papua, since 1959. In the early days of Papuan mining a length of 4,000 ft. along the Umuna lode channel yielded 114,000 fine oz. of gold from the oxidized zone. The Umuna channel is considered to be the dominant feature in gold occurrence on the Island. Since December, 1959, the company has done 46,000 ft. of reconnaissance costeaning, 8,000 ft. of detailed costeaning, and underground work comprises 385 ft. of driving and 92 ft. of cross-cutting. No. 1 adit has been completed, the distance from portal being 365 ft. A cross-cut of 52 ft. cut oxidized lode formation 23 ft. wide.

Some two miles north-west of the Umuna workings a probable extension of the Umuna lode channel has been met and is being costeaned. Such an extension would indicate a length of channel of 16,000 ft. It is reported that other lodes have been cut.

Aluminium.—A report states that the aluminium enterprise at Weipa, North Queensland, should commence operations in 1966. Harbour work is proceeding and is to be speeded up by a second dredge which has been landed and will be working by the end of the year. The channel will be dredged to a depth of 27 ft. When this work has been completed, in 18 months' time, the port will be able to accommodate ocean-going cargo ships. When construction and preparatory work is finished the Weipa deposit will supply alumina to the Bell Bay, Tasmania, aluminium works, which is now obtaining supplies of bauxite from Malaya and Indonesia.

The hydro-electric power project and the aluminium smelter at Bluff, New Zealand, when completed will permit Weipa alumina to be shipped to New Zealand for processing at Comalco's works, at Invercargill. It is considered that the Commonwealth Aluminium Corporation's operations will not be affected by the projected Alcoa enterprise, based on Western Australian bauxite deposits and production of aluminium metal at Port Henry, Victoria.

Cobar.—The Cobar copperfield was formerly one of the greatest fields in Australia and between 1870 and 1919 some 10 mines were in production. Of these the Great Cobar mine produced 4,000,000 tons of ore before the price of copper forced its closure and the abandonment of the field. The field was revived by the New Occidental Company between 1933 and 1952, but was ultimately forced to close down by increasing costs. Later on leases were taken over the old mines by Broken Hill South and the Consolidated Zinc Corporation and extensive diamond drilling carried out.

Following a decision that the areas could be best developed under one control, operations reverted to Broken Hill South and have since been carried out by two subsidiaries of that company, which have spent about £A1,000,000 in prospecting over a period of about five years The South company has now issued preliminary information on the work done. Large tonnages of payable ore are reported to have been indicated by diamond drilling estimated at 18,000,000 tons. Grades of ore indicated by the drill intersections are 3·76% and 4·04% copper as averaged. It is now planned to sink a shaft to a depth of 1,500 ft. on the old C.S.A. mine for the examination of the lode and the ore. This mine was the last worked on the field, with the exception of the New Occidental, the New Cobar, and the Chesney. It had its own smelter and produced 103,000 tons of ore. When production is resumed under Broken Hill South concentrates will be railed to the smelter of the Electrolytic Refining and Smelting Co. at Port Kembla. This company has been facing difficult times against Japanese competition for copper concentrates and the operation of Mount Isa Mine's copper refinery at Townsville. The C.S.A. mine at Cobar is well placed, being six miles out of the town of Cobar, which has direct rail connection with Sydney.

Mount Isa.—The industrial dispute at Mount Isa continues. The Mount Isa men are among the highest paid and enjoy the best living conditions in Australian mining communities, with modern township, good housing, adequate water supply, electric power, and light. They have free picture shows and ample high-class recreational facilities established and maintained by the company. The dispute has arisen over the amount of the bonus paid to employees (£8 per week) over and above high award wages and liberal paid annual leave. Despite these conditions the Australian Workers Union is demanding an increase in the bonus to £25 per week, and the craft unions are demanding £26 14s. 4d. per week. On the company refusing the demands the unions imposed an overtime ban on all operations and the reversion of contract miners to wages, thus seriously curtailing output in an effort to force their demands. A four-hour stoppage was announced, and the company advised the unions that if this took place the mine would be closed down. As this stoppage took place the mine was accordingly closed down until such time as the men returned to work under the terms and conditions of their award.

The Industrial Court has refused to intervene in the matter of the bonus. The unions have claimed that the action of the company is a lock-out but the Industrial Court has declared otherwise. A move to obtain unemployment benefits for the men has been met by a definite refusal by the Commonwealth Government as the men are involved in an industrial dispute. The loss in wages by the men amounts to more than £20,000 per week; many of the employees have been financed by the company in house purchase and domestic purchases and the company has announced a moratorium deferring payments, hire-purchase payments, and house deals. The company has advertised that work will be available one clear shift after an assurance is given that union members will work in accordance with the award and with the Queensland Industrial Conciliation and Arbitration Act.

FAR EAST

October 25.

Tin.—After attending the recent meeting in London of the International Tin Council, which failed to fix new floor and ceiling prices, Senator Chan Kwong Hon of Malaya has accused various tin-consumer countries of being most unco-operative in not agreeing to a realistic price range for the metal. At the conference Malaya and other producers had sought a floor price of £800 a ton and a ceiling price of £1,000. Senator Chan stressed that the Federation delegation to the next meeting of the Council in February should continue to fight with the same vigour for a realistic price range. Although no agreement had been reached the meeting was important because the United States now realized, he said, how the producing countries felt on the question of price and at what level the ceiling should be.

The question of price and future availability of tin would have to be considered if the interests of producers and consumers were to be safeguarded on a long-term basis, said Mr. K. J. Cumming, presiding at the annual general meeting of Austral Malay Tin, Ltd., and associated companies in Taiping. "In considering the former," he said, "it should be borne in mind that the richer deposits of tin have either been or are being worked out and consumers must perforce be prepared to pay a sufficient price to encourage the opening up of marginal mines. As to the latter, while it is appreciated that a higher tin price has a psychological effect on market sentiment, I venture to suggest that what concerns consumers far more is the possibility that future supplies may be insufficient to meet their needs. . . . lack of confidence in this regard if allowed to develop would merely lead to greater interest being taken in substitutes." He emphasized that releases from the American stockpile could only serve as a palliative and the world must look for its future long-term requirements to the producing countries. Regarding the tin-mining industry in Malaya Mr. Cumming said indications were that there would be a steady decline in output unless more mining land was made available. "Time is running short and the authorities, particularly state governments, should devote their immediate attention to this pressing problem."

Consolidated Tin Smelters.—Details of an offer for sale by Consolidated Tin Smelters, Ltd., of 45% of its holding in the Eastern Smelting Co., Ltd., have been announced. Malayans, it was stated, were to be offered 4,500,000 one dollar shares in Eastern Smelting at $2·25 per share. At a meeting in Penang recently the company transferred the seat of control of Eastern Smelting to the Federation of Malaya. Under an agreement with the Straits Trading Co., Ltd., Eastern Smelting is now dealing with a share of the ore which Indonesia is sending to Malaya for treatment.

India.—A new plant for the production of

special steels is to be located at Durgapur, West Bengal, next to the integrated steelworks. The project report has been examined and accepted by Hindustan Steel and the Indian Government and preparatory work at the site started recently. Most of the engineering services for setting up the plant "are capable of being provided by Indian firms." Only major parts of the plant and equipment would have to be obtained from abroad.

Buffer Stock Contributions.—The Federation of Malaya Government has reduced tin miners' contributions to the International Tin Agreement's Buffer Stock to (Malayan) $24 a picul for the three months to December 31. A memorandum sent to the Government by the All-Malaya Chinese Mining Association, with the backing of the F.M.S. Chamber of Mines, urged that the contribution rate be reduced. The October rate of $39, it was stated, had imposed a heavy burden on Chinese tin miners and made it uneconomical for marginal mines to operate.

Washing Plant for Bauxite.—Aluminium, Ltd., has announced the building of a washing plant for bauxite at Sungei Ringgit, near Ramunia, Johore, Malaya. The plant would be for bauxite mined by a subsidiary—South-east Asia Bauxites, Ltd. The plant, to be completed next April, is to have a total yearly capacity of 500,000 tons and to be operated by a newly-established mining service company—Johore Mining and Stevedoring Co., Ltd., an associate of South-East Asia Bauxites. Since the last-named company started mining operations in Johore in 1939 demand for the ore has grown tremendously. The principal customer is Nippon Light Metal Co., Ltd., a Japanese affiliate.

SOUTHERN AFRICA

October 28.

Reserve Bank.—The South Africa Reserve Bank comments that internal economic expansion was at a relatively slow rate in the second quarter of the current year; expenditure on consumption declined while gross domestic saving increased considerably mainly due to substantially higher personal saving. This was accompanied by notably increased gross domestic capital formation arising from slightly improved inventory investment and private fixed investment. Decreased indices related to imports, retail sales, value of building plans passed, property transactions, commercial bank discounts and advances; gold production was maintained; increased indices related to exports, railway earnings, and bank debits (public deposits). Stock exchange turnover sharply declined. Reduced imports and a slightly higher net gold output, a lower net private capital outflow, accompanied by a net outflow of capital due to transactions of official and banking institutions, resulted in a net decline in the gold and exchange reserves in the second quarter against a small increase in the first period.

General.—A more comfortable outlook for the acid-producing plants of the gold mines, which faced a surplus of production through the scaling down of uranium production, arises from plans of African Explosive and Chemical Industries, Ltd., to erect a new superphosphate factory at Modderfontein, on the outskirts of Johannesburg. The other main raw material, phosphate, will be drawn from increased output of concentrates produced from the Phalaborwa deposits of the Phosphate Development Corporation, Ltd.

Diamonds.—Practical application of diamonds to toughen up metal-bearing surfaces subjected to heavy duties and difficult lubrication circulation is expected to follow successful experiments conducted in the United Kingdom. Diamond dust was placed between two equally hard surfaces which, rubbed together, showed that the diamond particles entered both surfaces with equal ease and that with prolongation of the rubbing the protruding edges are removed by the abrasion. The result is a padding of diamond surfaces above the smooth metal surface which acts as an ultra hard bearing surface.

Ultra High Pressure Units, Ltd., established by the De Beers Consolidated Mines, Ltd., group in association with Belgian interests, particularly the Société Minière du Beceka, for the production of synthetic industrial diamond grit, has commissioned its factory at Springs on the East Rand. The installation at present includes 75 hydraulic 500-ton presses. Output is to be restricted as long as Congo boart supplies are normally delivered.

Underground Settlers.—A modified design of an underground settler, considered to be generally more efficient than conventional types, is under investigation by the National Mechanical Engineering Research Institute, in collaboration with the National Institute for Water Research, on behalf of certain mining companies in a general programme of research into settlement and pumping of mine waters and the reduction of pump wear. Advantages are that adequate flocculation of water sedi-

ments is provided for. The system is hydraulically efficient and operates over a wide range of flow rates and turbidities and the volumes of excavations for the modified settler are smaller than for conventional settlers. A 5-ft. diameter pilot plant successfully handled vertical flow rates between 1 in. and 5 in. per minute (equivalent to between 30 gal. and 150 gal. per hour per sq. ft. of surface area) and inflow turbidities between 100 parts and 12,000 parts per million and yielded an outflow of clear water. Research continues into optimum dimensions of the settler, the most economical flow rate relative to costs of flocculating chemicals, and applications outside mining. After the addition of flocculating chemicals and thorough mixing the turbid water is introduced tangentially into outer cones and spirals downwards to simple guide vanes which eliminate the rotational velocity and permit an even radial flow downwards and into the inner cone. Under most conditions a so-called floc-blanket is formed in the inner cone and this blanket acts like a fine deep sieve, impeding and ultimately stopping the upward flow of particles. The supernatant clear water flows through V-notches into the overflow channels.

Medical Statistics.—In reviewing statistics of the Anglo American Corporation of South Africa, Ltd., group for 1960 the medical consultant—Dr. J. H. G. van Blommestein—commented that the policy is now to integrate medical services wherever they are needed with all the various mining operations as it has been generally accepted that such integration proves to be of inestimable value to all concerned.

Lost Shifts.—In respect of the Rand and Far West gold mines lost shifts declined for disease but increase for accidents.

Morbidity Rates.—These generally declined in respect of the Rand and Far West gold mines and appreciably in the case of the Free State mines under all headings. Collieries, on the other hand, reflected a general increase in the rates and, due to the inclusion of Williamson Diamonds, Ltd., also in the case of diamond mines. On the Copperbelt mines the rates for disease declined but rose for accidents and other causes.

Mortality Rates.—In 1960 the Anglo American group employed an average number of 151,380 Africans, among whom the mortality rate was 3·36 deaths per 1,000 per annum for all causes—the lowest rate on record. Only under the heading " Other Causes " was there an increase in the mortality rate to 0·74 from 0·54 per 1,000—that for accidents declining to 1·25 from 1·42 per 1,000 and that for disease to 1·37 from 1·52 per 1,000. In respect of mortality from disease pneumonia claimed the highest toll followed by heart and pericardium diseases, which normally occupied first place. Diseases of the liver are on the increase. On the Rand and Far West gold mines disease mortality was reduced but mortality from mining accidents and from other accidents increased. On the Free State mines the rate for disease and other causes rose but was reduced for accidents. The rate for collieries declined in all categories and on the diamond mines declined for disease but rose for accidents, the overall rate being slightly lower. On the Copperbelt mines the rate rose in all divisions.

The report dealt in some detail with diseases of the lungs. Pulmonary tuberculosis mortality rate increased slightly on the Rand and Far West gold mines but declined on the Free State mines, the collieries, and appreciably on the Copperbelt mines. Mass miniature radiography has assisted materially in the early detection of both pulmonary tuberculosis and the pneumoconioses. The intensive use of this has resulted in a reduction of pneumoconiosis without tuberculosis on all mines but with tuberculosis the morbidity rate for all mines increased slightly. Throughout 1960 it was noted that a number of cases did not respond to antibiotic treatment for pneumonia, probably accounting for the increased mortality rate for the disease in respect of all mines. The morbidity rate declined appreciably. The greatest number of bronchitis cases occurred during 1960 on the Free State gold mines but the incidence for all mines rose slightly for all mines of the group. One of the most important aspects of occupational medicine is the reduction of accidents. During 1960 more decisive measures were implemented. These included a new classification for the Free State mines, which will be extended to all mines of the group. Regarding amputation, the greatest number were due to loss of finger tips, thumb tips, or toes. Although the morbidity rate decreased on the gold mines of the group a very marked increase was noted in the number of compensatible accidents in some of the East Rand mines. The Copperbelt mines showed a slight increase in the number of accidents while the collieries generally decreased their number of accidents and deaths from mining accidents.

Radio Communication Underground.—Two major problems had to be resolved by the Research Laboratories of the Transvaal and Orange Free State Chamber of Mines and the National Institute of Telecommunication Research of the South African Institute for

Scientific and Industrial Research in adapting radio communication to underground mining conditions, especially for fire-fighting and rescue operations. One was the transmission directly through rock which was resolved by the determination that 335 kc. was the optimum frequency. The other was suitable media for transmission from the nearest " fresh-air " base and reply from the affected working area which was solved by the use of audio-communication from the base and telegraphic or morse reply from the affected area. A base transmitter set was evolved comprising a transmitter-receiver of 29 lb., a battery of 33 lb., and a loop-aerial of 16 lb. The apparatus carried by the fire-fighter or rescue-worker weighs 13½ lb. and comprises a receiver-transmitter with a small loudspeaker and morse key and a frame passing over the wearer's shoulder to support the apparatus and carry the loop aerial. Manufacture is at present effected in the research laboratories of the Chamber.

Gold Mines.—At West Driefontein the driving of cross-cut haulages has been completed to the site of the second sub-vertical shaft of the No. 5 Shaft system in the extreme south-western section, at which site the stage and kibble hoist chambers and the Koepe hoist chamber have been completed and to the site of No. 3 Sub-vertical Shaft in the south-central section where cutting of the Koepe hoist chamber and access-ways to the kibble and stage hoist chambers is now proceeding. A holing has been effected with the completed No. 4 Shaft from No. 3 in the northern section of the mine. Cross-cutting southwards from No. 4 to the sub-outcrop zone of the Ventersdorp Contact Reef is in progress. The extension of reef development eastwards on this relatively erratic horizon in the vicinity of the site of No. 3 sub-vertical confirms expectations that payability and doubtless values will be appreciably lower than in the high-grade south-western section. The longwall method of stope-blocking and mining is now general policy in the mine. The company has completed sinking the No. 4 Shaft in the extreme north-eastern section to a final depth of 4,780 ft. below the collar and equipping, which is in progress, should be completed within the next nine months or so. The mine is now milling a substantial tonnage of Ventersdorp Contact Reef ore, together with the higher-grade Carbon Leader Reef ore.

Libanon Gold Mining is in the final stages of equipping its Harvie-Watt Shaft in the extreme southern section and sinking proceeds in the new ventilation shaft of the No. 1 Shaft system in the northern section. The higher-grade Ventersdorp Contact Reef ore in the mill feed was reflected in the higher yield of 5·123 dwt. a ton in the third 1961 quarter.

Adverse geological conditions and retarded development on the Basal Reef is reflected in the slow build-up of the milling rate by Free State Saaiplaas to the monthly average of 62,700 tons in the third 1961 quarter from the 53,400 tons in the preceding six months.

City Deep, Ltd., has acquired two mynpachten, equivalent to about 144 claims, representing an extension of the south-western section of the mine.

Harmony Gold Mining has apparently completed its off-reef development in the foot-wall of the Basal Reef horizon westwards from the more northerly No. 2 Shaft and will probably step up reef development and sampling in the immediate future.

Coal.—At Vierfontein Colliery, operated for a period of 17 months with one producing shaft and working three producing shifts daily, the sales output in the 12 months to mid-1961 were 1,293,722 tons. Following the closing of the East Shaft in March, 1960, a new incline, the South East, was started in August but sinking from surface was hampered by soft and broken ground requiring heavy reinforcement at increased costs. This was partly offset by developing from the East Shaft to the underground site of the new shaft, raising and holing through to the sunken depth, and then sliping to the full dimensions. Installation of the conveyor-belt system connecting up with the washing plant was followed by commissioning the shaft for production in August. At the West Shaft normal double-shift working has been resumed from which area extensive development has been advanced from areas of adverse roof conditions into the southern section where mining conditions are better. The Electricity Supply Commission has met the whole cost of the new shaft.

Company News.—Consolidated African Mines has acquired a mining company working a metallurgical fluorspar deposit in the Swartruggens area of the Western Transvaal, for the output from which there is regular export demand. The company has also taken up options over properties in the Postmasburg–Kuruman areas of the Northwestern Cape and is investigating these for their manganese and iron-ore potential.

The South African Minerals Corporation has announced the completion of a preliminary investigation of its nickel deposits in the Pilansberg area of the Western Transvaal with not unpromising results.

Trade Notes

Brief descriptions of developments of interest to the mining engineer

Lubricating Mine Hoist Ropes

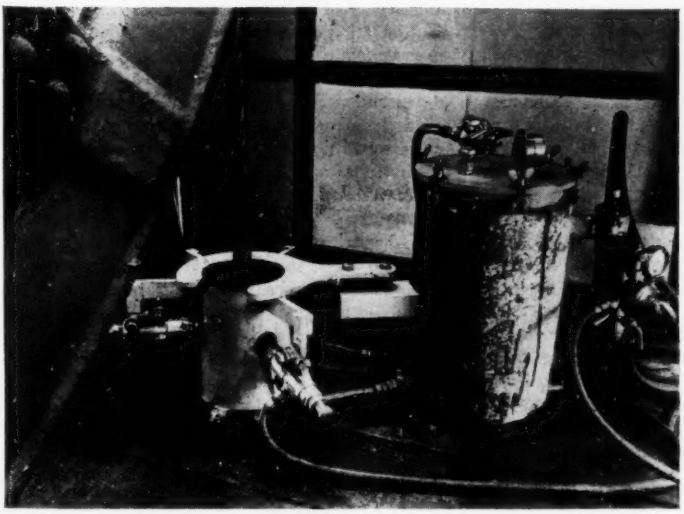
Some notes have been made available on an experiment with a new and speedier method of lubricating mine-hoist ropes by means of sprays instead of grease boxes. The illustration shows three spray guns rigged at 120°-angles to each other around the hoist rope on No. 3 Shaft of Van Dyke Consolidated Mines, Ltd., at Boksberg. It is understood that the outcome of the experiments will be known soon. It was originally started by the **Noxal Company S.A. (Pty), Ltd.,** of Johannesburg, when it became known that engineers were interested in a method of lubrication with a liquid dressing, and they rigged up a mock headgear and used Atlas Copco Ecco 30A automatic spray guns designed for another purpose.

To establish the periods for which the guns should operate four Noxal Company's engineers sat in shifts in a day-and-night vigil in the headgear for several weeks, operating the spray guns manually. The automatic unit was then installed.

Earth Resistivity Measurement

Particulars have been released of a new instrument for earth resistivity determinations by **ABEM,** of Danderydsgatan, 11, Stockholm, Sweden. The company recall that in 1949 they introduced hand-cranked a.c. equipment for determinations down to several hundreds of feet under the surface. Since then more than 80 such instruments have been delivered all over the world. From the extensive field experience accumulated under a wide variety of topographic, climatic, and geological conditions, their research and development engineers have been able to design an instrument which not only embodies the latest electronic techniques but which also exceeds the high operating standards of its predecessor, it is stated.

The new Terrameter is a compact, lightweight, fully tropicalized, very-low-frequency a.c. instrument capable of achieving consistent high-quality results under difficult conditions. The instrument units are of the all-weather type being fully tropicalized and sealed against ingress of water, damp, and dust. Using internally-



Mine Rope Lubrication.

fitted standard dry batteries, the Terrameter is simple to operate and requires little or no maintenance, the special feature being its insensitivity to disturbances from stray electric currents from nearby power lines, radio, and TV transmitters, or ground telluric currents, which so often upset measurements. The high sensitivity and the high instrumental accuracy—$\pm 3\%$ for readings as low as 0·01 ohm and $\pm 10\%$ for readings of 0·003 ohm—make it suitable for use in structural investigations down to depths of 2,000 ft. at $\rho = 50$ ohms and make it possible to carry out fast, reliable, and economic resistivity surveys for ore prospecting, water exploration, and depth-to-bedrock determinations.

Personal

D. H. BATCHELOR has been appointed a director of Geevor Tin Mines, Ltd., in succession to Mr. J. H. BENNETTS, who died on September 22.

J. R. CHILES is home from Uganda.

S. O. FORD is visiting Egypt.

G. HARVEY has left for Ghana.

H. L. HOLLOWAY has left for Spain.

H. R. HOLMES has resigned from the board of the Central Provinces Manganese Ore Co., Ltd.

I. D. W. MACPHERSON is home from Sierra Leone.

J. C. MITCHESON, a member of the Geological Survey Board since 1959, has been appointed Chairman of the Board in succession to *Sir* WALTER DRUMMOND.

DERECK MORRIS has left for Ceylon.

E. H. N. PHILLIPS is home from Canada.

J. F. PRESTON has been appointed head of the Research Department of African Explosives and Chemical Industries, Ltd.

J. M. PRYOR is now in Northern Rhodesia.

W. S. RAPSON, vice-president of the Council for Scientific and Industrial Research in Pretoria, has been appointed research adviser to the Transvaal and Orange Free State Chamber of Mines.

B. L. SETCHELL is here from Canada.

W. W. WALKER has left for Ghana.

CHARLES VICTOR BRENNAN, for many years general manager of the Britannia Mining and Smelting Co., Ltd., died in Seattle on October 1, aged 74. Trained at McGill University, he had gained experience in Utah, Cuba, and at Trail, British Columbia, before joining Britannia.

CHARLES ARTHUR BANKS died on September 28 at Vancouver after a long illness. Mr. Banks was born in New Zealand in 1885 and received his early technical training and practical experience in that country, going to Canada in 1912. During World War I he served as a tunnelling officer in the Royal Engineers, following the cessation of hostilities returning to Canada for Selukwe Gold Mining and Finance Co. of London. In 1926 Mr. Banks formed an exploration company along with the late W. A. FREEMAN (of Sydney, Australia) as president and himself as managing director. The company was later incorporated in British Columbia as Placer Development, Ltd., with world-wide powers of exploration and operation. The first property acquired was in the Territory of New Guinea and was developed and brought into production by Bulolo Gold Dredging, Ltd., the story of which entails the first history of heavy transportation by airplane. That operation was spectacularly successful from the outset. Since then the operations of Placer Development and its subsidiaries have expanded enormously. In recognition of the Bulolo operation Mr. Banks was in 1938 awarded the Gold Medal of the Mining and Metallurgical Society of America, while in further recognition, he was in 1956 elected an honorary member of the Institution of Mining and Metallurgy for "his services to the mining industry, with particular reference to his pioneering work in the introduction of air transport for the equipment of poorly accessible mineral properties." In 1944 the late Dr. T. A. RICKARD dedicated his book "The Romance of Mining" to Charles Banks with the inscription, "whose professional career has been alike honourable, successful, and romantic." He was appointed C.M.G. in 1946 and from 1946 to 1950 he was Lieutenant-Governor of the Province of British Columbia.

THE INSTITUTION OF MINING AND METALLURGY

Elections and Transfers

Member.—P. A. C. DANIELSSON, M.S. (*Lidingo, Sweden*); W. F. EBERTH (*Johannesburg*); R. S. GAVRIAS, B.S. (*Nicosia*); R. N. HAMMON, B.Sc. (*Bakuru*); C. P. JOURNEAUX, A.C.S.M. (*Akwatia, Ghana*); D. SHACKLEY, B.Sc. (*Penrith*).

Associate Member to Member.—L. D. AIREY, A.R.S.M., B.Sc. (*Mufulira*); D. T. BUCHANAN, Dip. S.A.S.M. (*Mount Isa*); H. DUDLEY, A.C.S.M. (*Nagpur*); K. N. ENGEL, B.Sc. (*London*); W. E. GABBITAS, A.C.S.M. (*Batu, Gajah*); D. A. HARKIN, B.Sc. (*Dodoma*); S. R. R. HOOD, A.C.S.M. (*La Oroya, Peru*); D. MORRIS, A.R.S.M., B.Sc. (*Kotiyakumbura, Ceylon*).

Associate Member.—S. DIJKSTRA, M.Ing. (*Kamativi, S. Rhodesia*); D. GRIFFITHS (*Sutton*); T. H. HUGHES (*Bygrave*); D. V. JACKSON, A.R.I.C. (*Stevenage*); J. A. LORD, B.Sc. (*Konongo*); A. MCCRIRICK, B.Sc., A.R.I.C. (*Kalalushi*); H. A. ROBINSON (*Penge, Transvaal*); T. A. SCRIMINGER, A.R.S.M., B.Sc. (*Doncaster*); H. K. TAYLOR, A.R.S.M., B.Sc. (*Chingola*); J. C. WILSON, B.Sc. (*Hitchin*).

Student or Affiliate to Associate Member.—M. G. BATCHELOR, B.Sc. (*Carletonville, Transvaal*); A. K. CHANT, B.Sc. (*Tarkwa*); H. K. COLE, A.C.S.M. (*Nsuta*); B. A. FERGUSON, B.Sc. (*Eldorado, Sask.*); D. W. FOMISON, A.R.S.M., B.Sc. (*Mufulira*); D. B. FRASER, A.R.S.M., B.Sc. (*St. Johns, Newfoundland*); R. G. HOLLOWELL (*Corrimal, N.S.W.*); T. B. KELYNACK, A.C.S.M. (*Bibiani*); I. C. KNIGHT, A.R.S.M., B.Sc. (*Kalalushi*); W. MORRIS (*Carletonville, Transvaal*); I. R. POLLARD, A.C.S.M. (*Elliot Lake, Ont.*); S. M. SINGH, A.C.S.M. (*Calcutta*); P. W. H. SOUTER, A.C.S.M. (*Sudbury, Ont.*); D. M. WILLIAMS, A.C.S.M. (*Eldorado, Sask.*); A. J. WRIGHT, A.R.S.M., B.Sc. (*London*); P. V. YOUNG, A.R.S.M., B.Sc. (*Knob Lake, Que.*).

Affiliate.—T. St. H. ACLAND (*Redruth*); J. S. CLARK (*Batu Gajah*); A. CORNOCK (*Sungei Besi*); S. GHALEB, B.Sc. (*Cairo*); L. Y. SIP (*Ipoh*); J. R. P. LINE (*Luanshya*); W. G. MOFFAT (*Kitwe*); A. H. W. PURKISS, B.Sc. (*Mufulira*); B. R. WILLIAMS, B.Sc. (*Mufulira*).

Student.—M. J. R. BOON, B.Sc. (*Kitwe*); S. K. CHAN, A.C.S.M. (*Ipoh*); A. R. B. H. DAHAN (*Camborne*); I. Ll. ELLIOTT, B.Sc. (*Awsworth*); C. G. S. JANES, B.Sc. (*Chingola*); T. A. NURHONEN, A.C.S.M. (*Redruth*); P. R. TYSON (*Dunedin, N.Z.*); P. M. T. WHITE (*Edenvale, Transvaal*).

Metal Markets

During October [1]

Copper.—During October two features influenced thinking in connexion with copper and both have been somewhat technical matters closely related to the operations of the London Metal Exchange. The first, which developed almost as soon as the month began, was what was called influential buying—a phrase much used in recent years in reporting the London market; it refers to active, if not aggressive, buying of copper by interests known to be linked with producers. Owing to the secrecy which surrounds London Metal Exchange operations it is never conclusively proved that the ring members responsible for this buying are in fact operating on behalf of producing interests but the belief is sufficiently well founded and widespread to influence market thinking. As far as this particular month is concerned the influential buying was materially assisted by a fairly sharp rate of decline in the level of stocks in London Metal Exchange approved warehouses. Again the belief was widespread that these two developments were connected although the outside observer would not be qualified to assert that this was so. At all events the pattern of price movements [2] was of a sharp improvement in cash prices which was by no means matched by three months prices, with the result that the contango (the premium of three months over cash) was markedly narrowed and was in fact in danger at one time of disappearing altogether. This was, of course, an untoward event from the point of view of consumers and other holders of copper hedging on the market as it is only when there is a reasonable contango that this activity does not extract a small, albeit justifiable, penalty.

The other main event of the month was the outbreak of a troublesome strike at the big Mount Isa mine in Australia which was still effective when the month closed. At the same time the Chilean struggle may have to be re-enacted if the 60 days of grace in the strike at two mines is allowed to run out without a new contract being negotiated, which it may do in mid-November. General industrial conditions in Europe were mixed in October and this was true of copper as of many other things, but in America the tone turned from gloom to brightness.

Consumption of copper in the U.K. in August was 40,920 tons, of which 31,003 tons was

[1] Recent prices, pp. 264, 300.
[2] See Table, p. 300.

refined. Production of primary refined was 6,787 tons and of secondary refined 6,248 tons, reflecting the holiday month. Stocks of refined copper rose noticeably to 127,715 tons and of blister by a small amount to 25,183 tons.

Tin.—October saw the twice-delayed meeting of the International Tin Council held and also the continuation of the discomfiture which has faced this international organization for a considerable part of the year, particularly since June when it ran out of metal and lost any power of action along the lines which it was set up to pursue. For the first time on record the Council had to put a controversial question to the vote. The question was whether the limits in the agreement should be raised to £800 to £1,000 as some producing countries proposed. The voting was not favourable to this proposal which is the first time that there has been an open breach between the producing and consuming interests on the agreement. This situation has been a rude awakening to the many economists and apologists for Government intervention in business who have been energetically boosting the Tin Agreement as a successful international commodity price stabilizing organism. The impotence of the Agreement in the present situation of world tin was highlighted by the fact that the next meeting of the Council is not to be held until February, 1962. By that time, as the most naive onlooker is aware, the U.S. Congress will have re-convened and perhaps some new light will be thrown on the two matters now of paramount importance—*i.e.*, whether the U.S. will associate herself with the Tin Agreement, as she promised Bolivia she would, and/or whether Congress would agree to the proposal which was made earlier this year to set aside a certain amount of U.S. Government strategic stockpile holding of tin for release to the market. The London market has lost none of its ability to assess a situation no matter how complex during the last few years when a lot of the initiative has been taken out of its hands by the Tin Agreement and it has evidently decided that whatever happens higher tin prices are likely to be the order of the day. As a result prices in London have embarked on an upward move which could easily carry without much interruption to about £1,000 a ton as the first stop.[1]

U.K. August consumption was 1,446 tons and production 1,842 tons. Stocks slipped back further to 8,350 tons.

Lead and Zinc.—Lead and zinc have been lumped together in most people's minds during the past month because the fortunes of both markets were to be significantly governed by developments at the Geneva meeting of the International Lead and Zinc Study Group. Completing the triumph, at any rate for the time being, of the forces of the law of supply and demand in the battle against economic management the meeting, like that of the International Tin Council, was a complete failure more or less, certainly in any of the objectives that had been hoped for it. In a long but not very helpful communiqué at the end of the meeting the members of the Group revealed that their earlier intention to hold world production to 2% less than consumption had not been outstandingly successful in spite of the fact that nearly 100,000 tons had been bartered to the U.S. Government as was anticipated.

Apart from some increase in Eastern bloc sales over what was anticipated the main weakness of lead was the failure of consumption to live up even to the modest expectations that were entertained earlier. In zinc, statistical prognostications were not so far out and the situation, whilst not cheerful, was not felt bad enough to warrant any action to influence the supply and demand equation.

U.K. lead consumption in August was 24,816 tons and production was 5,191 tons. Stocks rose noticeably to 74,876 tons. In the case of zinc, consumption remained low at 21,501 tons whilst production was 7,640 tons. Stocks rose sharply to 70,637 tons.

Iron and Steel.—There was no improvement in the U.K. steel market during October and the industry appears to be resigned to a sluggish rate of demand persisting for the remainder of the year. Output of steel in the month was not expected to prove much better than September when the industry operated at only 77% of capacity.

Consumption of steel in this country has remained at a fairly good level. The weakness of the market is actually the result of a lack of demand from users, who are running down their stocks. In addition, the existence of spare capacity is now resulting in very prompt deliveries and the fact that consumers can be certain of obtaining their needs at short notice is further affecting their buying policy.

The export market remains very competitive and British iron and steel has experienced mixed fortunes this year. September shipments were the lowest for over two years but the total for the first three quarters of 1961 at 2,545,357 tons was slightly higher than the January–September period of last year. A disappointing feature of

[1] See Table, p. 300.

foreign trade in 1961 is the decline in exports of tinplate and tubes and pipes.

Meanwhile the Steel Company of Wales' Margam and Abbey works were idle for 16 days during the month as a result of a strike by bricklayers. The company managed to keep its tinplate works at Velindre and Trostre going at reduced rates by securing supplies of hot coil from elsewhere.

Iron Ore.—The big cut in pig-iron production in the U.K. in addition to considerable stocks which have accumulated has resulted in a substantial reduction in imports of iron ore. Arrivals in the first three quarters of the year declined by 12% to 11,935,378 tons from 13,569,557 tons in the corresponding period of 1960.

Aluminium.—Aluminium has continued a highly competitive market throughout the world in October. There had been earlier indications that the position in the U.S.A. might be gaining strength in response to the generally better economic indications from that direction which are certainly being borne out in other directions. However, something of a bombshell was dropped in the U.S. market when Aluminium, Ltd., announced that it was prepared to sell Canadian aluminium to U.S. consumers at the going Canadian price of 23·25 Canadian cents per lb. at the frontier. This price has always been advantageous on paper since the U.S. domestic price went to 26 cents, but it has offered a really tangible advantage ever since the Canadian dollar went to a discount on the U.S. dollar. The only thing preventing the Canadian company from taking this action earlier has been its scrupulous adherence to selling in the U.S. market at the going U.S. domestic price. The U.S. producers necessarily countered the Canadian move by reducing their domestic price to 24 U.S. cents per lb., with which the Canadians have now aligned. In the U.K. the price is maintained at £186 per ton delivered.

Antimony.—October has been a dull month for both antimony regulus and ore from the market point of view. However, this has not prevented Chinese antimony from again supplying a significant proportion of U.K. requirements of metal. As far as domestically-produced antimony is concerned prices have been held unchanged at £230 per ton for 99% and £237 10s. for 99·6%.

Arsenic.—There has been no change in the arsenic situation ; very little metallic arsenic is used metallurgically these days, most consumers prefering to use the trioxide. The price of the latter remains £40 to £45 per ton and of metal £400 a ton.

Cobalt.—So far U.K. consumption of cobalt in one of its major outlets—in the production of magnets and other parts for the radio and television industry—does not seem to have been affected by the general deterioration in U.K. consumer goods industries following the stiffening of the U.K. credit structure earlier this year. The U.K. price to contract buyers remains 10s. 9d. per lb.

Cadmium.—The cadmium market has been occupied in October with thoughts in connexion with a proposed scheme of obtaining drawback of duty on cadmium used in making exported cadmium pigments. Technical difficulties have arisen because a significant proportion of U.K. cadmium imports does not pay duty. The net effect to consumers should be a reduction in their effective buying price—always assuming that the base price on the U.K. market is not raised in the meantime. At present the basic cadmium price remains 11s. per lb. delivered.

Chromium.—Although figures are not available it appears U.K. domestic chromium metal consumption is doing quite well. However, the big exports market built up in earlier years is now not so active. The domestic price remains 6s. 11d. to 7s. 4d. per lb.

Tantalum.—With the established uses for tantalum metal still advancing strongly tantalite buyers are now competing keenly with one another for the limited quantities available. In line with last month's forecast, the published indication for 60% tantalite has improved to 1,600s. to 1,700s. per unit c.i.f.

Platinum.—There is nothing very spectacular to report from the platinum front for October. The seasonal improvement in the jewellery trade is now getting under way but it is, of course, very many years since industrial uses of platinum became vastly more important than jewellery uses. Industrial use is fair but not good and the price of the main suppliers is held at £30¼ per oz. The market in Russian metal is very thin and maintained almost nominally at £27½ to £28 per troy oz.

Iridium.—There is no fresh news about iridium and the price is still indicated between the limits £20 per oz. and £26 15s. per oz.

Palladium.—The electrical industry continues to take useful quantities of palladium from the main sellers at £9¾ per troy oz., while the small quantities of Russian palladium available are offered at £8½ per troy oz.

Osmium.—Trade in osmium continues so small as to be almost indiscernible and a price indication of £17 to £25 per troy oz. is maintained.

Tellurium.—Pending the dawn of the new era which is promised for tellurium as an important metal in electronics, established users are not always able readily to secure quantities additional to their historical allocation from their regular suppliers. The supply of tellurium is definitely limited but for the time being the price indication for material going to established outlets remains 37s. 6d. per lb.

Tungsten.—October has been another bad month for the tungsten-ore market; consumers have scarcely shown their faces in the market and those that have tested the situation have been flooded with cheap offers from ready sellers. The fact that the price has so far only declined to 117s. to 119s. per unit is only due to the small number of sales which have been made. However, sellers hope for a chance to stabilize the price so as to halt the perpetual deferment of consumer buying in anticipation of lower prices; then, it is still believed, some useful tonnages could be moved.

Nickel.—There have been no significant new developments in nickel in October and in view of the industry's capacity to produce more nickel than has ever been used in the past this promotion-conscious industry is likely to gird its loins for a bigger and better selling drive. The price remains £600 a ton.

Chrome Ore.—The better reports from the American steel industry and economy generally now coming to hand will be welcome news for chrome-ore producers. In Europe, which has been the area of the fastest growing stainless-steel production and chrome consumption, the economic impetus has gone out of a number of markets and this includes stainless steel—not least in the U.K., the second largest producer in this area. For Rhodesian metallurgical chrome the price remains £15 5s. per ton c.i.f., while the Turkish indication continues at $30 per ton f.o.b.

Molybdenum.—A little more steam has gone out of the molybdenite market in October, which means that it is now merely healthy instead of being a boom market. The f.o.b. Climax price remains 10s. per lb. Mo.

Manganese.—Manganese ore has been devoid of new features in October, which means that certain sectors of the industry have maintained a fair tonnage but indifferent price and other sectors have not even maintained tonnage. The c.i.f. Europe price continues to be indicated at 66d. to 69d. per unit for 46% to 48% ore.

Tin, Copper, Lead, and Zinc Prices

Tin, minimum 99·75%; Copper, electro; Lead, minimum 99·75%; and Zinc, minimum 98%, per ton.

Date		Tin		Copper		Lead		Zinc	
		Settlement	3 Months	Spot	3 Months	Spot	3 Months	Spot	3 Months
		£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Oct.	9	942 0	951 10	228 2½	228 17½	63 5	64 17½	71 16¼	72 18¾
	10	949 0	958 10	226 17½	227 12½	63 1¼	64 13¾	71 11¼	72 16¼
	11	942 0	952 10	228 17½	229 7½	63 3¾	64 13¾	71 16¼	72 18¾
	12	944 0	953 10	230 17½	230 17½	62 18¾	64 11¼	71 16¼	73 1¼
	13	946 0	954 10	232 17½	232 12½	63 3¾	64 16¼	72 3¾	73 7½
	16	943 0	950 10	231 17½	231 17½	63 3¾	64 13¾	72 1¼	73 3¾
	17	937 0	945 10	230 12½	230 17½	63 6¼	64 13¾	72 6¼	73 8¾
	18	940 0	947 10	229 12½	229 12½	63 2½	64 8¾	72 13¾	73 13¾
	19	941 0	948 10	229 17½	229 17½	63 12½	64 16¼	72 17½	73 18¾
	20	942 0	947 5	230 12½	230 7½	63 8¾	64 13¾	72 7½	73 7½
	23	943 0	946 10	229 17½	230 7½	62 11¼	63 18¾	71 8¾	72 8¾
	24	944 0	948 10	228 17½	229 2½	61 18¾	63 3¾	71 3¾	72 6¼
	25	948 0	951 10	228 12½	229 2½	60 15	62 1¼	71 1¼	72 1¼
	26	954 0	956 10	228 7½	229 2½	61 12½	62 16¼	70 17½	71 18¾
	27	953 0	954 10	228 7½	229 7½	61 17½	62 18¾	70 18¾	71 16¼
	30	958 0	958 15	228 7½	229 2½	60 18¾	62 1¼	71 1½	71 17½
	31	964 0	963 10	227 17½	228 7½	61 8¾	62 8¾	71 7½	72 3¾
Nov.	1	971 0	969 10	228 2½	228 12½	61 16¼	62 16¼	71 11½	72 8¾
	2	980 0	974 15	228 17½	229 7½	62 2½	62 16¼	71 8¾	72 3¾
	3	977 0	971 10	229 15	230 2½	61 17½	62 8¾	70 18¾	71 17½
	6	973 0	969 15	229 17½	230 7½	61 17½	62 12½	71 1½	71 18¾
	7	970 0	967 15	230 17½	231 2½	61 12½	62 8¾	70 1¼	71 5
	8	967 10	967 15	231 12½	231 12½	60 17½	61 17½	69 11¼	70 16¼
	9	973 10	972 10	231 17½	232 2½	60 7½	61 2½	68 11¼	69 16¼
	10	—	—	—	—	—	—	—	—

Statistics

TRANSVAAL AND O.F.S. GOLD OUTPUTS

	September		October	
	Treated Tons	Yield Oz.*	Treated Tons	Yield Oz.†
Blyvooruitzicht	140,000	86,828	142,000	88,119
Brakpan	142,000	18,896	146,000	18,978
Buffelsfontein‡	156,000	68,584	157,000	69,491
City Deep	112,000	23,456	117,000	24,456
Cons. Main Reef	39,000	8,764	38,000	8,501
Crown Mines	178,000	31,382	171,000	29,826
Daggafontein	224,000	45,566	228,000	46,013
Dominion Reefs	40,600	—	42,500	—
Doornfontein‡	125,000	54,056	125,000	54,069
D'rb'n Roodeport Deep	196,000	31,382	206,000	38,744
East Champ D'Or‡	12,500	252	12,500	244
East Daggafontein	108,500	18,717	109,000	18,934
East Geduld	122,000	34,282	122,000	34,282
East Rand P.M.	235,000	57,025	233,000	56,415
Eastern Transvaal Consol	20,300	6,048	20,600	6,064
Ellaton‡	23,000	5,535	23,000	5,521
Freddies Consol	65,000	10,907	65,000	12,589
Free State Geduld	99,500	87,095	100,000	87,910
Free State Saaiplaas	66,000	18,086	67,000	18,389
Geduld	75,000	12,558	74,000	12,327
Government G.M. Areas‡	34,000	7,650	32,000	7,451
Grootvlei Proprietary	225,000	46,529	230,000	46,840
Harmony Gold Mining	194,000	78,286	197,000	79,541
Hartebeestfontein‡	136,000	62,356	136,000	62,560
Libanon	119,000	30,901	119,000	31,531
Loraine	85,000	28,900	85,000	29,537
Luipaards Vlei‡	110,000	14,218	110,000	14,166
Marievale Consolidated	99,000	23,520	99,000	23,523
Modderfontein East	62,000	6,464	64,000	6,135
New Kleinfontein	65,000	9,844	71,000	9,937
New Klerksdorp‡	—	—	—	—
President Brand	133,000	103,085	133,000	102,789
President Steyn	112,000	42,150	114,000	42,651
Rand Leases	180,000	25,020	163,000	23,309
Randfontein‡	105,000	8,711	104,000	8,710
Rietfontein Consolid't'd	12,000	3,106	12,000	3,102
Robinson Deep	51,000	10,060	50,000	9,870
Rose Deep	25,000	4,209	25,000	4,295
St. Helena Gold Mines	185,000	64,758	187,000	65,454
Simmer and Jack	72,000	12,357	71,000	12,305
S. African Land and Ex.	113,000	22,792	110,000	22,387
S. Roodepoort M.R.	30,000	7,313	30,000	7,314
Spaarwater Gold	11,200	3,638	11,200	3,618
Springs	97,000	14,263	99,000	14,354
Stilfontein Gold Mining‡	185,000	83,100	190,000	84,960
Sub Nigel	66,500	15,162	66,500	15,155
Transvaal G.M. Estates	—	—	—	—
Vaal Reefs‡	118,500	55,695	123,000	57,810
Van Dyk Consolidated	75,000	10,907	74,000	10,601
Venterspost Gold	130,000	39,332	130,000	39,351
Village Main Reef	37,000	4,533	35,900	4,488
Virginia O.F.S.‡	143,000	28,572	136,000	27,921
Vlakfontein	53,000	19,626	53,000	19,631
Vogelstruisbult‡	80,000	17,284	80,000	17,293
Welkom Gold Mining	105,000	33,596	107,000	34,291
West Driefontein‡	182,000	142,860	182,000	142,879
West Rand Consol.‡	216,000	22,229	221,000	23,233
Western Holdings	175,000	122,503	175,000	123,375
Western Reefs	155,000	45,182	155,000	45,182
Winkelhaak	98,000	33,321	98,000	33,321
Witwatersrand Nigel	19,400	4,275	19,500	4,279

* 251s. 8d. † 249s. 7d. ‡ Gold and Uranium.

COST AND PROFIT IN THE UNION *

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
June, 1960	17,968,300	73 9	46 3	27 6	31,941,743
July	—	—	—	—	—
August	—	—	—	—	—
Sept.	18,103,100	74 0	46 4	27 8	32,201,685
Oct.	—	—	—	—	—
Nov.	—	—	—	—	—
Dec.	17,272,800	76 2	47 0	29 2	33,039,583
Jan., 1961	—	—	—	—	—
Feb.	—	—	—	—	—
Mar.	17,858,100	—	—	—	31,924,315
April	—	—	—	—	—
May	—	—	—	—	—
June	18,419,350	—	—	—	65,772,460†

* 3 Months. † R.

PRODUCTION OF GOLD IN SOUTH AFRICA

	Rand and O.F.S.	Outside	Total
	Oz.	Oz.	Oz.
October, 1960	1,777,495	35,967	1,813,462
November	1,775,624	36,159	1,811,783
December	1,744,406	34,044	1,778,450
January, 1961	1,785,614	34,407	1,820,021
February	1,759,373	32,046	1,791,419
March	1,837,280	38,843	1,876,123
April	1,837,511	29,437	1,866,948
May	1,885,415	42,062	1,927,477
June	1,887,594	35,858	1,923,452
July	1,899,248	34,977	1,934,225
August	1,926,670	40,346	1,967,016
September	1,921,304	37,228	1,958,532

NATIVES EMPLOYED IN THE SOUTH AFRICAN MINES

	Gold Mines	Coal Mines	Total
January 31, 1961	384,816	33,513	418,329
February 28	396,533	33,577	430,110
March 31	398,626	33,736	432,362
April 30	398,012	34,005	432,017
May 31	396,437	33,587	430,024
June 30	392,591	33,180	425,771
July 31	389,255	33,200	422,455
August 31	382,733	33,244	415,977
September 30	381,659	33,203	414,862

MISCELLANEOUS METAL OUTPUTS

	4-Week Period To Oct. 14		
	Tons Ore	Lead Concs. tons	Zinc Concs. tons
Broken Hill South	13,400	2,312	2,743
Electrolytic Zinc	19,538	834	5,459
Lake George	16,565	1,245	2,200
Mount Isa Mines**	13,863	1,050†	1,184
New Broken Hill	51,420	6,619	11,978
North Broken Hill	27,327	5,108	5,345
Zinc Corp.	40,940	5,633	8,427
Rhodesia Broken Hill*	—	3,817†	7,414†

* 3 Months, ** Copper 560 tons blister; 1,545 tons concs.; † Metal.

RHODESIAN GOLD OUTPUTS

	Sept.		Oct.	
	Tons	Oz.	Tons	Oz.
Cam and Motor	—	—	—	—
Falcon Mines	21,600	4,277	22,400	4,525
Globe and Phœnix	4,590	2,607	4,750	2,695
Motapa Gold Mining	12,528	—	12,214	—
Mazoe	2,666	—	2,687	—
Coronation Syndicate	—	—	—	—
Phœnix Prince*	32,050	2,786	—	—

* 3 Months.

WEST AFRICAN GOLD OUTPUTS

	Sept.		Oct.	
	Tons	Oz.	Tons	Oz.
Amalgamated Banket	—	—	—	—
Ariston Gold Mines	—	—	—	—
Ashanti Goldfields	37,500	32,250	38,500	33,000
Bibiani	—	—	—	—
Bremang	—	—	—	—
Ghana Main Reef	—	—	—	—
Konongo	7,600	4,341	7,900	3,954
Lyndhurst	—	—	—	—

PRODUCTION OF GOLD AND SILVER IN RHODESIA

	1960		1961	
	Gold (oz.)	Silver (oz.)	Gold (oz.)	Silver (oz.)
January	44,902	29,711	47,673	22,101
February	45,754	29,865	44,164	13,250
March	45,309	29,656	52,507	7,256
April	48,607	6,847	50,090	7,992
May	47,542	62,912	—	—
June	45,884	34,298	51,497	7,129
July	44,865	33,323	48,088	8,070
August	48,284	28,931	—	—
September	48,865	38,951	—	—
October	47,473	37,308	—	—
November	46,439	33,896	—	—
December	48,778	26,327	—	—

WESTRALIAN GOLD PRODUCTION

	1959	1960	1961
	Oz.	Oz.	Oz.
January	63,924	64,794	62,434
February	65,035	66,789	73,271
March	65,408	61,941	69,360
April	62,686	65,373	62,569
May	64,184	66,682	66,352
June	74,590	74,902	81,562
July	78,974	67,623	61,886
August	68,546	67,466	71,894
September	66,501	68,794	67,831
October	70,427	67,310	—
November	68,858	107,815	—
December	117,474	76,269	—
Total	861,122	855,758	—

AUSTRALIAN GOLD OUTPUTS

	4-Week Period			
	To Sept. 12		To Oct. 10	
	Tons	Oz.	Tons	Oz.
Central Norseman	14,100	7,496	13,739	7,212
Gold Mines of Kalgoorlie	39,353	11,366	40,428	11,667
Gt. Boulder Gold Mines*	—	—	—	—
Gt. Western Consolidated	33,695	4,657	33,072	4,989
Lake View and Star*	—	—	186,255	42,453
North Kalgurli	28,017	7,111	—	—
Sons of Gwalia	12,592	3,532	—	—
Mount Morgan	—	5,063	—	3,834

* 3 Months.

ONTARIO GOLD AND SILVER OUTPUT

	Tons Milled	Gold Oz.	Silver Oz.	Value Canad'n $
May, 1960	784,391	225,550	32,174	7,765,153
June	791,488	223,833	49,765	7,756,490
July	779,426	222,179	37,002	7,664,968
August	712,792	202,025	35,722	6,883,254
September	772,984	208,019	29,251	7,114,785
October	805,753	228,914	33,808	7,860,787
November	785,133	230,377	31,149	7,917,352
December	783,501	229,639	37,560	8,020,961
January, 1961	804,026	227,771	27,776	7,901,743
February	737,859	214,763	33,291	7,465,046
March	814,951	234,228	34,181	8,128,958
April	770,931	225,836	32,949	7,842,394
May	794,700	233,162	34,071	8,088,356
June	762,113	210,470	33,080	7,626,339
July	698,924	201,746	30,333	7,308,414
August	706,283	196,926	28,900	7,200,769

MISCELLANEOUS GOLD AND SILVER OUTPUTS

	Sept.		Aug.	
	Tons	Oz.	Tons	Oz.
Clutha River	—	528	—	570
Lampa (Peru)†	—	52,668	—	—
New Guinea Goldfields	4,104	1,968	—	—
Yukon Consol.	—	$375,000	—	—

† Oz. Silver : Copper, 101 tons ; 166 tons.

AUSTRALIAN BASE-METAL OUTPUTS

Period	Concentrate Production (Long Tons)		
	Zinc	Copper (*a*)	Lead
1960	290,596	104,889	297,510
Provisional			
1961—January	15,070	8,169	15,540
February	26,716	8,265	26,437
March	27,535	9,680	26,146
April	23,759	9,548	21,279
May	29,032	9,017	28,155
June	28,259	8,821	28,669
July	24,856	8,976	22,827
August	—	—	—
September	—	—	—
October	—	—	—
November	—	—	—
December	—	—	—

(*a*) includes Cu content of direct smelting ore.

OUTPUTS OF MALAYAN TIN COMPANIES IN LONG TONS OF CONCENTRATES

	Aug.	Sept.	Oct.
Ampat Tin	60	61½	—
Austral Amalgamated	—	—	—
Ayer Hitam	—	315*	—
Berjuntai	320	258	—
Chenderiang	19	21½	—
Gopeng Consolidated	171	169	—
Hong Fatt (Sungei Besi)	—	—	—
Hongkong Tin	69	75	—
Idris Hydraulic	25	27	—
Ipoh	14	9	—
Kampong Lanjut	163	184½	—
Kamunting	144	117	—
Kent (F.M.S.)	36	42	—
Kepong	—	66*	—
Killinghall	11	12	—
Kinta Kellas	11	13½	—
Kramat	35½	36	—
Kuala Kampar	125	137½	—
Kuala Lumpur	—	—	—
Kuchai	—	—	—
Larut	20	21	—
Lower Perak	93½	155½	—
Malayan	173	174	—
Pacific Tin Consolidated	—	—	—
Pahang Consolidated	—	634*	—
Pengkalen	58	52	—
Petaling Tin	110	90	108½
Rahman Hydraulic	37	—	—
Rambutan	19	17	—
Rantau	64	59½	—
Renong	—	—	—
Selayang	—	—	—
Siamese Tin Syndicate (Malaya)	38	40	40
Southern Kinta	412	380	—
Southern Malayan	340	272	—
Southern Tronoh	—	36*	—
Sungei Besi	—	459*	—
Sungei Kinta	—	—	—
Sungei Way	—	474*	—
Taiping Consolidated	32½	37	—
Tanjong	66½	57	—
Tekka	—	—	—
Temoh	—	—	—
Tongkah Harbour	145	151	—
Tronoh	—	503*	—

* 3 Months.

NIGERIAN MINE OUTPUTS (TONS)

	July	Aug.
Cassiterite	818	883
Columbite	208	225
Felspar	—	—
Gold*	62	60
Kaolin	—	—
Lead Ore	—	—
Limestone	61,266	67,236
Monazite	1	1
Oil	237,361	—
Tantalite	3	2
Thorite	—	—
Tin Metal	73	70
Wolfram	—	—
Zircon	71	44

* Oz.

MISCELLANEOUS TIN COMPANIES' OUTPUTS IN LONG TONS OF CONCENTRATES

	September		October	
	Tin	Columbite	Tin	Columbite
Amalgamated Tin Mines	452	87	—	—
Anglo-Burma Tin*	—	—	—	—
Bangrin	19	—	40	—
Beralt	3	182†	—	—
Bisichi	—	—	—	—
Ex-Lands Nigeria	62	—	50	—
Fabulosa	—	—	—	—
Geevor	58	—	—	—
Gold and Base Metal	71	6	—	—
Jantar Nigeria	16	51	—	—
Jos Tin	19	—	—	—
Kaduna Prospectors	9	—	—	—
Kaduna Syndicate	27	—	—	—
Katu Tin	9	—	11	—
Keffi Tin	—	—	—	—
London Nigerian Mines	—	—	—	—
Mawchi Mines	—	—	—	—
Naraguta Extended	—	—	—	—
Naraguta Karama	9	—	—	—
Naraguta Tin	—	—	—	—
Ribon Valley (Nigeria)	—	—	—	—
Siamese Tin Syndicate	119	—	113	—
South Bukeru	—	—	—	—
South Crofty	66	—	—	—
Tavoy Tin	—	—	—	—
Tin Fields of Nigeria	—	—	—	—
United Tin Areas of Nigeria	27½	1½	—	—

* 3 Months. † Wolfram.

SOUTH AFRICAN MINERAL OUTPUT

August, 1961.

Gold	1,961,666 oz.
Silver	212,075 oz.
Diamonds	334,582 carats.*
Coal	3,843,636 tons.
Copper	(*a*) 32 tons in matte and copper-gold concentrates. (*b*) 4,784 tons of 98·96%.
Tin	234 tons concs.
Platinum (concentrates, etc.)	—
Platinum (crude)	—
Asbestos	15,996 tons.
Chrome Ore	90,144 tons.
Manganese Ore	165,402 tons.
Lead Concs.	10 tons.

* *July, 1961.*

IMPORTS OF ORES, METALS, ETC., INTO UNITED KINGDOM

		Aug.	Sept.
Iron Ore	tons	1,406,600	1,246,383
Manganese Ore	,,	40,203	46,478
Iron and Steel	,,	40,954	43,615
Iron Pyrites	,,	21,938	33,746
Copper Metal	,,	43,317	31,748
Tin Ore	,,	5,729	2,237
Tin Metal	,,	116	170
Lead	,,	17,249	15,166
Zinc Ore and Conc.	,,	21,366	15,637
Zinc	,,	13,992	11,110
Tungsten Ores	,,	707	511
Chrome Ore	,,	26,738	11,690
Bauxite	,,	30,755	40,887
Antimony Ore and Concs.	,,	1,264	1,057
Titanium Ore	,,	4,445	23,285
Zirconium Ores and Concs.	,,	1,057	3,603
Tantalite/Columbite	,,	47	6
Sulphur	,,	41,855	26,132
Barytes	,,	3,692	3,333
Asbestos	,,	13,636	12,409
Magnesite	,,	16,990	7,644
Mica	,,	529	318
Graphite	,,	564	807
Mineral Phosphates	,,	124,643	93,021
Molybdenum Ore	,,	1,130	472
Silicon	,,	481	614
Nickel	cwt.	94,747	72,489
Aluminium	,,	411,857	342,494
Mercury	lb.	24,362	146,716
Bismuth	,,	9,938	—
Cadmium	,,	204,309	178,433
Cobalt	,,	261,004	252,508
Selenium	,,	44,818	8,875
Petroleum, Crude	1,000 gal.	1,064,658	894,957

Prices of Chemicals

The figures given below represent the latest available.

		£	s.	d.
Acetic Acid, Glacial	per ton	104	0	0
,, ,, 80% Technical	,,	94	0	0
Alum, Comml.	,,	25	0	0
Aluminium Sulphate	,,	16	5	0
Ammonia, Anhydrous	per lb.		1	6
Ammonium Carbonate	per ton	59	0	0
,, Chloride	,,	30	2	6
,, Nitrate	,,	36	5	0
Antimony Sulphide, golden	per lb.		4	4
Arsenic, White, 99/100%	per ton	47	10	0
Barium Carbonate 98–99%	,,	42	0	0
,, Chloride	,,	45	0	0
Barytes (Bleached)	,,	20	0	0
Benzene	per gal.		5	6
Bleaching Powder, 35% Cl.	per ton	30	7	6
Borax	,,	46	10	0
Boric Acid, Comml.	,,	77	10	0
Calcium Carbide	,,	40	17	9
,, Chloride, solid, 70/75%	,,	17	0	0
Carbolic Acid, crystals	per lb.		1	2
Carbon Bisulphide	per ton	62	10	0
Chromic Acid	,,	245	0	0
Citric Acid	per cwt.	8	14	0
Copper Sulphate	per ton	78	0	0
Creosote Oil (f.o.r. in Bulk)	per gal.		1	3
Cresylic Acid, refined	,,		8	2
Hydrochloric Acid 28° Tw.	per carboy		13	6
Hydrofluoric Acid, 59/60%	per lb.		1	1
Iodine	per kilo		17	4
Iron Sulphate	per ton	3	5	0
Lead, Carbonate, white	,,	110	5	0
,, Nitrate	,,	112	0	0
,, Oxide, Litharge	,,	99	0	0
,, Red	,,	97	0	0
Lime Acetate, brown	,,	40	0	0
Lithopone	,,	57	10	0
Magnesite, Calcined	,,	20	0	0
,, Raw	,,	13	0	0
Magnesium Chloride	,,	20	0	0
,, Sulphate, Comml.	,,	15	10	0
Methylated Spirit, Industrial, 66 O.P.	per gal.		5	10½
Nickel Sulphate	per ton	207	0	0
Nitric Acid, 70° Tw.	,,	35	0	0
Oxalic Acid	,,	132	0	0
Phosphoric Acid (S.G. 1·750)	per lb.		1	4
Potassium Bichromate	per ton	131	16	8
,, Bromide	per lb.		2	6
,, Carbonate (hydrated)	per ton	72	10	0
,, Chloride	,,	21	0	0
,, Iodide	per kilo		19	3
,, Hydrate (Caustic) flake	per ton	92	0	0
,, Nitrate	per cwt.	3	10	0
,, Permanganate	,,	10	3	0
,, Sulphate, 50%	per ton	21	12	6
Sodium Acetate	,,	63	0	0
,, Arsenate, 58–60%	,,	Nominal		
,, Bicarbonate	,,	18	0	0
,, Bichromate	,,	109	13	4
,, Carbonate (Soda Ash) 58%	,,	16	0	6
,, Chlorate	per ton	90	0	0
,, Cyanide	per cwt.	6	18	10
,, Hydrate, 98/99%, solid	per ton	35	6	6
,, Hyposulphite, Comml.	,,	35	0	0
,, Nitrate, Comml.	,,	Nominal		
,, Phosphate (Dibasic)	,,	40	10	0
,, Prussiate	per lb.		1	0½
,, Silicate	per ton	16	0	0
,, Sulphate (Glauber's Salt)	,,	12	5	0
,, ,, (Salt-Cake)	,,	10	0	0
,, Sulphide, flakes, 60/62%	,,	40	12	6
,, Sulphite, Comml.	,,	27	15	0
Sulphur, American, Rock (Truckload)	,,	13	0	0
,, Ground, Crude	,,	17	10	0
Sulphuric Acid, 168° Tw.	,,	12	0	0
,, ,, free from Arsenic, 140° Tw.	,,	8	10	0
Superphosphate of Lime, 18% P_2O_5	,,	13	10	0
Tin Oxide	,,	Nominal		
Titanium Oxide, Rutile	,,	172	0	0
,, White, 25%	,,	85	0	0
Zinc Chloride	,,	95	0	0
,, Dust, 95/97% (4-ton lots)	,,	115	5	0
,, Oxide	,,	90	10	0
,, Sulphate	,,	32	0	0

Share Quotations

Shares of £1 par value except where otherwise stated.

GOLD AND SILVER:	Oct. 6, 1961 £ s. d.	Nov. 6, 1961 £ s. d.
SOUTH AFRICA:		
Blinkpoort (5s.)	2 3 1	2 8 9
Blyvooruitzicht (2s. 6d.)	1 3 6	1 6 9
Bracken (10s.)	19 0	19 0
Brakpan (3d.)	3 9	4 0
Buffelsfontein (10s.)	1 12 6	1 13 6
City Deep	11 6	12 9
Consolidated Main Reef	11 9	12 3
Crown Mines (10s.)	17 3	18 3
Daggafontein (5s.)	16 9	17 6
Dominion Reefs (5s.)	18 6	1 0 3
Doornfontein (10s.)	1 6 3	1 7 6
Durban Roodepoort Deep (10s.)	1 4 0	1 5 6
East Champ d'Or (2s. 6d.)	1 3	1 6
East Daggafontein (10s.)	8 6	9 3
East Geduld (4s.)	14 9	14 0
East Rand Ext. (5s.)	16 9	16 3
East Rand Proprietary (10s.)	1 4 3	1 4 9
Freddies Consol.	1 9	1 9
Free State Dev. (5s.)	3 3	4 3
Free State Geduld (5s.)	4 2 6	4 15 0
Free State Saaiplaas (10s.)	4 3	3 6
Geduld	2 2 6	2 4 6
Government Gold Mining Areas (3d.)	1 6	1 6
Grootvlei (5s.)	14 9	16 0
Harmony (5s.)	1 1 0	1 1 9
Hartebeestfontein (10s.)	1 19 9	2 4 3
Libanon (10s.)	11 9	14 6
Loraine (10s.)	18 0	19 6
Luipaards Vlei (2s.)	8 0	8 3
Marievale (10s.)	1 3 3	1 5 3
Modderfontein B (3d.)	1 3	1 3
Modderfontein East	7 6	7 3
New Kleinfontein	4 9	4 9
New Pioneer (5s.)	1 8 0	1 8 3
New State Areas (15s. 6d.)	6	6
President Brand (5s.)	2 8 9	2 10 3
President Steyn (5s.)	14 3	13 6
Rand Leases (9s. 3d.)	4 3	4 6
Randfontein	16 6	19 6
Rietfontein (3d.)	2 0	2 0
Robinson Deep (3d.)	3 9	3 9
Rose Deep (3d.)	5 6	5 6
St. Helena (10s.)	2 17 9	3 5 0
Simmer and Jack (1s. 6d.)	1 0	1 3
South African Land (3s. 6d.)	13 6	14 3
Springs (3d.)	1 3	1 6
Stilfontein (5s.)	1 6 3	1 8 6
Sub Nigel (3d.)	7 3	7 0
Vaal Reefs (5s.)	1 17 6	1 19 6
Van Dyk (3d.)	1 6	1 9
Venterspost (10s.)	18 6	1 1 0
Virginia (5s.)	2 3	2 3
Vlakfontein (10s.)	13 3	15 0
Vogelstruisbult (3d.)	4 3	4 6
Welkom (5s.)	12 9	14 0
West Driefontein (10s.)	3 16 3	4 2 6
West Rand Consolidated (10s.)	14 9	17 3
West Witwatersrand Areas (2s. 6d.)	2 10 0	2 12 6
Western Holdings (5s.)	5 13 9	5 16 3
Western Reefs (5s.)	1 2 9	1 5 6
Winkelhaak (10s.)	18 6	18 9
Witwatersrand Nigel (2s. 6d.)	6	6
Zandpan (10s.)	6 6	6 6
RHODESIA:		
Cam and Motor (2s. 6d.)	—	—
Chicago-Gaika (10s.)	12 6	12 6
Coronation (2s. 6d.)	3 6	3 6
Falcon (5s.)	7 3	10 0
Globe and Phœnix (5s.)	1 8 9	1 9 6
Motapa (5s.)	—	—
GHANA:		
Amalgamated Banket (3s.)	—	—
Ariston Gold (3s. 6d.)	—	—
Ashanti Goldfields (4s.)	12 0	9 9
Bibiani (4s.)	—	—
Bremang Gold Dredging (5s.)	—	—
Ghana Main Reef (5s.)	—	—
Konongo (2s.)	9	9
Kwahu (2s.)	5 3	3 0
Offin River (2s. 6d.)	1 9	1 6
Western Selection (5s.)	3 6	3 6
AUSTRALASIA:		
Gold Fields Aust. Dev. (3s.), W.A.	1 9	1 9
Gold Mines of Kalgoorlie (10s.)	7 9	7 9
Great Boulder Propriet'y (2s.), W.A.	12 0	11 9
Lake View and Star (4s.), W.A.	1 2 9	1 2 6
Mount Morgan (10s.), Q.	11 6	12 3
New Guinea Gold (4s. 3d.)	1 3	1 6
North Kalgurli (1912) (2s.), W.A.	9 6	9 3
Sons of Gwalia (10s.), W.A.	2 6	2 3
Western Mining (5s.), W.A.	16 6	16 9

	Oct. 6, 1961 £ s. d.	Nov. 6, 1961 £ s. d.
MISCELLANEOUS:		
Fresnillo ($1·00)	2 0 0	1 18 9
Kentan Gold Areas	14 9	13 9
St. John d'el Rey, Brazil	4 0 0	4 12 6
Yukon Consolidated ($1)	3 0	3 3
COPPER:		
Bancroft Mines (5s.), N. Rhodesia	11 3	10 3
Esperanza (2s. 6d.), Cyprus	1 6	2 4½
Indian (2s.)	5 3	5 0
MTD (Mangula) (5s.)	6 9	6 9
Messina (5s.), Transvaal	12 9	13 3
Mount Lyell (5s.), Tasmania	5 9	6 3
Nchanga Consolidated, N. Rhodesia	2 4 0	2 5 3
Rhokana Corporation, N. Rhodesia	2 5 9	2 2 6
Roan Antelope (5s.), N. Rhodesia	5 3	4 0
Tanganyika Concessions (10s.)	19 3	18 6
LEAD-ZINC:		
Broken Hill South (1s.), N.S.W.	12 6	9 9
Burma Mines (3s. 6d.)	1 3	1 3
Consol. Zinc Corp. Ord.	3 2 6	2 19 3
Lake George (5s.), N.S.W.	3 3	3 3
Mount Isa, Queensland (5s. Aust.)	2 15 0	2 14 6
New Broken Hill (5s.), N.S.W.	2 5 6	2 1 3
North Broken Hill (10s.), N.S.W.	16 6	13 3
Rhodesia Broken Hill (5s.)	6 9	7 0
San Francisco (10s.), Mexico	18 6	18 6
TIN:		
Amalgamated Tin (5s.), Nigeria	11 3	10 0
Ampat (4s.), Malaya	15 9	16 3
Ayer Hitam (5s.), Malaya	2 2 6	2 6 0
Beralt (5s.), Portugal	1 5 6	1 3 0
Bisichi (2s. 6d.), Nigeria	4 9	4 6
Ex-Lands (2s.), Nigeria	3 9	3 9
Geevor (5s.), Cornwall	1 6 0	1 6 3
Gold Base Metals (2s. 6d.), Nigeria	1 9	1 9
Hongkong (5s.), Malaya	1 3 0	1 3 0
Jantar Nigeria (3s.)	5 3	5 6
Kaduna Syndicate (2s.), Nigeria	2 7½	2 9
Kamunting (5s.), Malaya	18 3	19 0
Malayan Tin Dredging (5s.)	1 12 0	1 10 0
Mawchi Mines (4s.), Burma	1 6	1 6
Naraguta Karama (5s.), Nigeria	1 0	1 0
Pahang (5s.), Malaya	16 9	16 6
Siamese Synd. (5s.)	18 3	19 0
South Crofty (5s.), Cornwall	6 6	7 6
Southern Kinta (2s.), Malaya	1 3 6	1 3 0
Southern Malayan (5s.)	1 11 0	1 15 0
Sungei Besi (4s.), Malaya	2 1 0	2 4 0
Sungei Kinta, Malaya	12 0	12 0
Sungei Way (2s. 4d.), Malaya	5 3	5 6
Temoh (7s. 6d.), Malaya	3 6	3 6
Tronoh (5s.), Malaya	—	1 10 6
United Tin Areas (2s. 6d.), Nigeria	1 9	1 4½
DIAMONDS:		
Anglo American Investment	12 5 0	13 10 0
Consol African Selection Trust (5s.)	15 6	15 9
Consolidated of S.W.A. Pref. (10s.)	8 0	7 9
De Beers Deferred (5s.)	6 10 3	7 0 0
FINANCE, ETC.		
African & European (10s.)	2 10 0	2 5 0
Anglo. American Corporation (10s.)	6 0 6	6 17 6
Anglo Transvaal 'A' (5s.)	1 7 9	1 9 0
British South Africa (15s.)	2 19 3	2 19 9
British Tin Investment (5s.)	16 3	17 6
Broken Hill Proprietary	2 15 3	2 15 0
Camp Bird (10s.)	5 4½	5 0
Central Mining	1 13 6	1 16 3
Central Provinces Manganese (10s.)	16 0	14 3
Consolidated Gold Fields	2 10 6	3 0 3
Consolidated Mines Selection (10s.)	1 4 9	1 8 3
Corner House	10 3	11 6
East Rand Consolidated (5s.)	1 9	1 9
Free State Development (5s.)	3 3	4 3
General Exploration O.F.S. (2s. 6d.)	2 9	3 3
General Mining and Finance	4 1 3	4 7 6
Hendersons (4s.)	7 3	8 3
Johannesburg Consolidated	1 19 3	2 5 9
London & Rhod. M. & L. (5s.)	8 0	8 9
London Tin Corporation (4s.)	16 9	15 6
Lydenburg Est. (5s.)	11 3	—
Marsman Investments (10s.)	2 7½	2 7½
National Mining	2 0	1 9
Rand Mines (5s.)	2 15 0	2 15 9
Rand Selection (5s.)	1 17 6	2 2 0
Rhodesian Anglo American (10s.)	2 14 3	2 14 6
Rhodesian Corporation (5s.)	1 9	1 9
Rhodesian Selection Trust (5s.)	8 3	8 3
Rio Tinto (10s.)	1 16 0	2 0 0
Selection Trust (10s.)	4 9 3	4 7 6
South West Africa Co. (3s. 4d.)	8 6	8 9
Union Corporation (2s. 6d.)	2 5 6	2 13 6
Vereeniging	4 10 0	5 3 3
West Rand Inv. Trust (10s.)	2 2 6	2 6 9

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section abstracts of important articles and papers appearing in technical journals and proceedings of societies are given, together with brief records of other articles and papers; also notices of new books and pamphlets and lists of patents on mining and metallurgical subjects.

Wet Magnetic Separation for Iron Ore

In the *Canadian Mining and Metallurgical Bulletin* for September W. J. D. Stone reviews the "Application of the Jones Wet Magnetic Separator to the Beneficiation of Iron Ore." The author says that, while concentration of magnetite is being achieved by low-intensity magnetic separators of both the wet and dry types, concentration of haematite and siderite is limited to dry separators of the high-intensity or electrostatic type. Dry magnetic separation has a serious drawback which is universally recognized—*i.e.*, that below 100 mesh separations generally cease to be sharp and, on even finer sizes, often ineffective for practical purposes. In addition, drying costs are always very high, while separations are even more complicated if the ore is of a clayey nature.

Most iron-ore operations, it is stated, work on a small margin of profit. Concentration of all the important iron-bearing minerals is highly desirable, including the valuable fine fractions often not now being recovered. The iron-ore industry has therefore long sought after a wet magnetic separator that would

(*a*) concentrate the main iron-bearing minerals together (magnetite, haematite),

(*b*) operate on an unsized feed,

(*c*) be effective on even fine material, and

(*d*) be economical.

The Jones separator, which meets these requirements, functions by means of an automatically-operated cycle of frequency 10 cycles to 15 cycles per min., the three stages of which are :—

(1) Collection of the magnetic particles from the feed on grooved plates in a magnetic field;

(2) cleaning of the magnetic particles by a pulsed stream of wash water, and

(3) removal of the magnetic particles from the plates by a decrease in magnetic-field strength together with an increased water velocity.

The Jones separator has now advanced well beyond the laboratory-pilot plant unit. Four sizes of machines will be available :—

(1) Laboratory-pilot plant unit for batch tests of 10 g. to 1,000 g. or 200 lb. to 400 lb. per hour continuous running;

(2) 800 lb. per hour;

(3) 6 tons per hour, and

(4) 40 tons per hour.

(1) The laboratory-pilot plant unit has been tested extensively for both performance and reliability. The test results obtained in iron-ore and other fields have proved that this equipment represents a major break-through in mineral dressing. The first laboratory pilot-plant unit produced was installed in Canada. This machine has been used extensively on all types of material and has given virtually trouble-free operation for two years. This is an indication of the soundness of design and construction. Units now under construction incorporate several improvements.

(2) The 800 lb. per hr. unit is a modification of the laboratory pilot-plant machine. This is a convenient size for special-purpose commercial and pilot-plant operations. Such a unit is now under construction for a haematite producer. It will be used to recover haematite fines from spiral tailings. This unit will be placed in circuit with a spiral in the operating plant for pilot-plant studies.

(3) The 6 tons per hr. unit is already designed and can be built to order. Overall size is 8 ft. 6 in. by 7 ft. 6 in. by 10 ft. high. Weight is about 6 tons.

(4) A 40-tons-per-hr. unit is planned for large-tonnage operations.

Early work quickly established that the Jones machine would readily make separations similar to those being obtained in existing plants treating iron ore—that is, separation of magnetite and coarse haematite. Due to the pressure of work on the available test unit efforts have therefore been concentrated on the more difficult separations.

There are several types of separation problems in the iron-ore field to which the Jones machine can be successfully applied. Some of these problems are listed below :—

(*a*) *Tailings*.—The tailings from several existing plants contain considerable iron values. In many instances the finer-sized haematite and in some cases the total haematite content of an ore is lost. Often very fine magnetite is being discarded. To recover these losses by one simple operation would be highly advantageous and could well result in a large increase in the profit margin.

(*b*) *Middlings*.—From middling products of spirals, etc., containing magnetite or haematite, or both, the Jones machine will often produce grade concentrates. In other cases regrinding of various middling products is necessary for liberation. By magnetic separation of these mixed particles prior to regrinding a great reduction in grinding costs could be achieved. The concentrate obtained would contain most of the iron values but would be only a fraction of the original bulk. Hence only this fraction would require regrinding, with consequent cost reduction. Often a barren tailing is readily achieved by the Jones separator.

(*c*) *Earthy Haematite*.—Some ores contain considerable percentages of earthy haematite, which is often very fine and only very feebly magnetic. Magnetic roasting of the whole has often been the only possible means of recovery of these values. This is a costly operation and often not practical. In some cases a grade concentrate of the earthy haematite can be made by separation on the Jones machine.

Some of these types of deposits contain quantities of iron-bearing silicates which sometimes concentrate along with the earthy haematite. However, in such cases the percentage weight of the concentrate will be only a fraction of the original and hence roasting costs will be greatly reduced, it being possible to discard a large volume of barren tailings.

There is no problem, however, in separating specular haematite, even in the micron range, from iron-bearing silicates as the haematite is separated at around 3 amps. current whereas most iron-bearing silicates require 10 amps. to 25 amps.

(*d*) *Clayey Deposits*.—There are some deposits of a very fine clayey nature. In such cases it is essential to disperse particles in a slurry form in order to make any physical separation possible. It was found on one such deposit that separation of even the magnetite fraction was not successfully achieved by conventional methods, due to the nature of the ore. However, a grade concentrate was produced by the Jones separator with the concentration of both haematite and magnetite with much of the material being less than 5 microns in size.

(*e*) *Very Fine-grained Haematite*.—The development of a simple process for the concentration of fine haematite has long been sought after. Its importance is indicated by the vast amount of research that has been devoted to this problem. Probably the most successful method to date incorporates magnetic roasting followed by magnetic separation ; a costly process. Much of the " non-magnetic " taconites fall into this category. Numerous successful separations have been made on the Jones separator on fine haematite—that is, 100% − 325 mesh. These include samples of " typical " non-magnetic taconite. This is probably one of the most important fields for investigation and development. Vast reserves of this material are available.

(*f*) *Titanium-bearing Ores*.—With titanium-bearing ores a very close control is required on the TiO_2 content of the iron concentrate. This, in turn, requires sharp separations to be made between particles varying only slightly in magnetic susceptibility. This control is readily obtained by control of field strength and wash-water pressure.

(*g*) *Phosphatic Ores*.—These materials are often fine-grained and require a good rejection of the P_2O_5-bearing minerals, chiefly apatite. This is obtained through the efficient washing cycle.

It has been shown that the Jones separator constitutes a major breakthrough in magnetic separation in general and particularly in the beneficiation of iron ore. Haematite, magnetite, and even siderite can be concentrated together, from unsized feeds ranging in particle size down to even a few microns. Simple separations have been made on materials hitherto considered difficult, if not impossible, by conventional methods. Cost of treatment will be low. Of particular importance is that power consumption for excitation will be less than 0·1 kWh/ton treated for specular haematite.

Test results and economics of operation indicate that extensive use will be made of this separator throughout the iron-ore industry.

In addition to being applicable to iron ore, the Jones separator can concentrate a wide range of other minerals down to the micron-size range. These include garnets, uranium, germanium, ilmenite, chlorite, mica, marmatite, columbite, wolfram, manganosiderite, iron-bearing silicates, pyrrhotite, etc.

Preconcentrating Flotation Feeds

An article by A. Mitzmager and J. Mizrahi in the *TBE* * *Bulletin* for October discusses the " Preconcentration of Flotation Feeds with TBE." The authors suggest that preconcentration of these ores by density separation makes possible the production of a finished concentrate and a middling for additional treatment or the reverse, and rejection of a waste, leaving an enriched product for further concentration. Preconcentration, they say :—

(*a*) Reduces the tonnage of ore to be treated in the flotation step. In some of the cases studied a preconcentration unit before a flotation plant would double or triple the capacity of the flotation equipment and reduce proportionally the consumption of reagents per ton of concentrate.

(*b*) Saves the cost of grinding extra tons of ore and of carrying it through the whole mill with all the involved expenses and complications.

(*c*) In most cases produces better metallurgical results. In each case the cost of the preconcentration step has to be weighed against the saving in investment and operating cost and the improvement in recovery and grade obtained.

Many flotation plants to-day use heavy-media separation for preconcentration in the coarse range (*minus* 3 in. *plus* ¼ in.). The TBE process extends the advantages of preconcentration to finer sizes (down to 100 mesh) and therefore fills the gap between the HMS and the flotation size ranges.

Three cases of ore samples examined in the authors' laboratories are described.

Case A.—A chalcopyrite ore sample contained about 1% copper. For a straight flotation process the whole ore should be ground to obtain liberation of the sulphides from the hard silica gangue. However, the liberation of an appreciable amount of gangue could be achieved at a coarse size, as can be seen from the data given in Table 1.

According to the figures given a sharp cut at sp. gr. 2·74 could eliminate 67·6% of the coarse (*plus* 100 mesh) fraction with a copper recovery of 96%. Taking into account the fines originally present in the crushed ore, the concentrate to be fed to the flotation plant (for the separation of the chalcopyrite from the pyrite and other heavy minerals) would be only 46% of the original feed with a consequent reduction in the capacity required for flotation and in the reagent consumption.

In order to ascertain if a pre-treatment in TBE would affect the flotation behaviour of the ore, tests were done in parallel by conventional roughing flotation and by roughing flotation after preconcentration in TBE. The results are given in Table 2.

Table 2

	Conventional.	*After preconcentration.*
% of the run-of-mine ore to grinding	80·0	25·8
% of the run-of-mine ore to flotation	100·0	46·2
Roughing weight %	7·14	6·72
Tailing weight %	92·38	93·26
Flotation tails	92·86	39·28
Coarse tails	0·00	54·00
Roughing assay, % Cu	11·8	12·7
Combined tailing assay, % Cu	0·20	0·12
Flotation tails, % Cu	0·20	0·23
Coarse tails, % Cu	—	0·054
Balance : % Cu in feed	1·028	0·965
Copper recovery, %	82·5	88·4

It can be seen, the authors suggest, that the

* Tetrabromoethane.

Table 1

Fraction size mesh, % by wt.	+ 28 45·3		− 28 + 48 21·2		− 48 + 100 13·1		Combined + 100 79·6		− 100 20·4	
Fraction, sp. gr.	% weight	% Cu	% weight	% Cu	% weight	% Cu	% weight	% Cu	% Cu	% of total Cu rejected in floats
Lighter than 2·673	49·0	0·052	54·5	0·055	56·9	0·059	52·0	0·054		2·26
Lighter than 1·736	69·2	0·073	66·2	0·070	64·2	0·068	67·6	0·0714	1·19	3·83
Lighter than 2·939	75·3	—	73·3	—	71·3	—	74·5	—		—

Table 3

Separation with TBE, sp. gr. 2·94

Fraction.	% *weight.*	% Pb.	% Zn.	*Distribution.* Pb.	Zn.
Feed . .	100·0	0·57	5·4	100·0	100·0
Fines (— 200 mesh) .	20·0	0·64	6·0	24·6	22·2
Concentrate (sink) .	15·0	2·40	24·0	69·1	66·7
Tails (float) .	65·0	0·05	0·92	6·3	11·1
Balance .	100·0	0·52	5·4	100·0	100·0

metallurgical results of the preconcentration scheme are better than the conventional process and should result in a substantial saving in grinding and flotation costs. Also the preconcentration by TBE does not impair the flotation properties of the ore.

Case B.—An oxidized lead-zinc ore from an existing plant was examined. It contained 5·4% Zn and 0·57% Pb, as sulphides, carbonates, and silicates of lead and zinc, in a complex and diffuse mineralization. This ore is actually treated by a classic flotation method after grinding the whole run-of-mine ore through 100 mesh and de-sliming the flotation feed. However, a substantial amount of barren material could be eliminated between the crushing and the grinding, as can be seen by the results given in Table 3 on the *minus* 14 mesh material.

A single cut on the *minus* 14 *plus* 200 mesh material can eliminate 65% of the feed with a recovery of 93·7% and 88·9% respectively on lead and zinc. 35% of the tonnage remains to be upgraded and differentially separated by selective flotation. Therefore, a TBE unit ahead of the flotation plant could triple its capacity with almost the same equipment and might substantially decrease the reagent consumption per ton of concentrate. The overgrinding of the soft ore and the resulting slime losses could be also decreased.

Case C.—The recovery of fine-size beryl from pegmatite presents another case of preconcentration. The direct flotation of beryl from low-grade ore (about 2% to 3% beryl) is very inefficient and complicated, while the upgrading of a beryl concentrate from 6% to 8% BeO to a marketable 10% to 12% is straightforward. The density process with TBE is therefore used to preconcentrate the ore from 3% to 60% beryl, recovering at the same time the other marketable minerals. The final separation of the beryl from the plagioclases of the same sp. gr. is then obtained by flotation.

Beneficiation of Beryllium Ore

A process for the beneficiation of beryllium ores employed by a United States company known as the Mineral Concentrates and Chemical Co., Inc., and called the "Mincon Process" is described in *Mining Engineering* for October. The process employs a "thermic-flotation" scheme and has reportedly resulted in a recovery ratio exceeding 90% and in allowing up-grading of beryllium concentrates to as high as 33%. It introduces a pelletizing and sintering stage used at the company's mill at Loveland, Colorado. The Loveland plant is processing beryl, bertrandite, and bertrandite-bearing greisen. Most of Mincon's ore comes from the U.S. Beryllium Corporation Boomer and Red Skin mines at Badger Flats, but the company is interested in increasing its sources of ore with new contracts and purchases from other producing mines.

At the Loveland plant ore is unloaded from trucks into a 25-ton capacity hopper and fed to a 6 in. by 12 in. Cedar Rapids jaw-crusher *via* a Syntron feeder and a conveyor. The ore is then stored in a series of bins, each bin holding different grades or types of ore to allow proper blending at this stage. The ore then passes through a Jeffery hammer-mill where it is reduced to *minus* 100 mesh. Depending upon the grade of ore at this step, the crushed product is diverted either to direct storage (if grade is high enough) or to a ball-mill and flotation circuit for further upgrading in the case of lean ores. In the first case ore is reduced to *minus* 320 mesh in a ball-mill before being sent by a pneumatic conveyor to a bin for weighing and feeding to a mixing hopper. In the latter instance a larger 5 ft. by 7 ft. ball-mill reduces ore to *minus* 200 mesh and the subsequent conditioning tanks and flotation cells produce a final grade of 15% to 30% BeO. This product is then sent to the dryer.

Fluxing agents (sodium carbonate and sodium fluoride) are added to the ore in the mixing hopper and the mixture is then fed to a pelletizer which produces approximately 1-in. diameter pellets. Pellets are fused in a sintering furnace at 1,750° to 1,800° F., depending upon

type of ore being processed. As the fused mass comes off the cooling end of the furnace it goes to a screw conveyor which crushes the product while conveying it to the sinter bin. The beryllium is dissolved when the sinter is made into a slurry when water and hydrogen peroxide are added. The slurry is then sent to a drag classifier where solids are removed on a Denver 3 ft by 5 ft. drum filter.

The pregnant liquor containing beryllium *plus* large quantities of other impurities is pumped to a 5,000-gal. settling tank for clearing, the liquor in the top portion of the tank being decanted to a 4,000-gal. settling tank for additional clarification. Pregnant liquor is then pumped *via* a surge tank through a series of Sparkler plates and frame filters into a 20,000-gal. storage tank. At this point the solution contains from 15 g. to 20 g. of BeO per litre *plus* about 1·5% iron, 2·5% silicon, 1·0% aluminium, 0·5% boron, 0·01% lithium, and 0·1% magnesium as well as other elements. The clarified solution is pumped through a filter which removed all suspended particles greater than 0·5 micron size. From the filter it goes into the two oxidation tanks where high-pressure air and additional chemicals are pumped into the bottom of the tank to float off contaminants. The purified pregnant liquor is then sent to the primary precipitation tank where beryllium hydroxide is precipitated by the addition of caustic soda. The beryllium hydroxide then goes to a wash tank for removal of some of the remaining impurities.

The beryllium hydroxide is concentrated to a thick paste in the evaporator units before being re-dissolved in nitric acid. Subsequent triple dehydration and filtration process removes the silicon. The beryllium nitrate solution is then concentrated and crystallized in the special crystallizer designed to produce a very fine crystal. The crystals are sent to a centrifuge where excess liquid is separated from the crystals which are subsequently dried at an extremely low temperature in a controlled atmosphere.

The crystals are re-dissolved in a mixture of alcohol and acetic acid and pumped to the liquid-liquid extration unit where the beryllium is precipitated from the solution with gaseous ammonia. This process of dissolving and precipitating the beryllium may be repeated two or three times, depending upon degree of purity required.

The resulting beryllium hydroxide is of very high density and all particles are spherical in shape. This is then filtered in an Eimco Burwell filter and placed into a steam dryer. A standard furnace re-built to Mincon's specification is used to calcine the oxide. If proper control is made on the solution and the hydroxide before calcining the resultant oxide has very uniform physical properties. A specially-lined vacuum system is used to pick up the oxide from the end of the furnace as calcination is completed.

Laboratory control is maintained throughout the entire process because of the very fine tolerances that must be maintained on the pH and temperature of the solution at all times. In addition, by using a beryllium analyser, all control points are kept under the control of one part-time operator.

New Leach Plant in Arizona

A description by J. R. Bogert of the new leach plant at the Bagdad Copper plant in Arizona appears in the *Mining World* of San Francisco for August. It was decided in 1959, the author says, that heap leaching of the dumps at the Bagdad mine would require the construction of a sulphuric acid plant. Work on this was begun in 1960 by the Fisher Contracting Company of Phoenix, with design and engineering work done in collaboration with the engineering staff of Bagdad. The 200 tons-per-day plant was completed in March and started operating in May. The plant, nearby precipitating launders, and surge pond, are all located on a small mesa approximately two miles north-west of the Bagdad open-pit. This was the only flat area available reasonably close to the dumps.

Heap leaching at Bagdad, according to the author, has its beginning with the purchase of molten sulphur in Louisiana from the Texas Gulf Sulphur Company. This is delivered in tank cars to the Santa Fe railroad siding at Hillside, Arizona, 28 miles south-east of Bagdad. Since the sulphur becomes partly solidified in transit, a special steaming plant at Hillside is used to empty the tank cars and return the sulphur to a molten state. Trailer tank trucks then carry the molten sulphur to underground storage at the acid plant at Bagdad. The insulated underground tank has a capacity of 250 tons and is equipped with steam lines to keep the sulphur continually molten.

The process of converting the sulphur to sulphuric acid is semi-automatic. It is controlled

by one man from a Minneapolis-Honeywell colour-guided schematic instrument panel where flow, temperatures, and pressures are automatically recorded.

Molten sulphur from underground storage is transferred by air pressure to a horizontal charge tank. It is then pumped to a sulphur burner where, together with dry air from a vertical drying tower, SO_2 gas is generated. This gas goes to a waste-heat boiler, through a heat exchanger, and to the first converter. This converter has two masses of vanadium pentoxide which act as a catalyst in converting the SO_2 to SO_3. After returning through the heat exchanger this last step is repeated through a second converter when conversion to SO_3 gas is theoretically complete. The SO_3 gas then passes through a cooler to an absorption tower where moisture (from the drying tower) is absorbed until sulphuric acid of 98% purity is attained. Excess SO_3 is released into the atmosphere. Operating continually this efficient plant produces 200 tons of H_2SO_4 acid per day which is stored in two 750-ton storage tanks.

Sulphuric acid from the storage tanks starts its work in the leaching operation at two small 890,000-gal. conditioning ponds near the precipitating launders. Here, acid is added to barren solution coming from the launders, bringing it up to a strength of 7·59 acid per litre of water. This then flows by gravity through a 4,500-ft. 14-in. diameter pipeline to the leach dump. This pipeline is made of stainless steel lined with polyvinyl chloride plastic.

There are two dumps at Bagdad that will eventually be treated by heap leaching. The largest dump is the Mineral Creek, the smallest the Alum Creek. Dump material is altered monzonite porphyry, mine run in size, containing approximately 0·435% acid-soluble copper in the form of malachite, azurite, and a little chrysocolla.

Present plans call for leaching only the Alum Creek dump. The top of the dump is divided into a series of connected ponds 100 ft. square and approximately 1 ft. deep. These shallow ponds control the distribution of the dilute sulphuric acid solution. By a system of rotating the flooding of the various ponds an even application of leach solution is applied which percolates through the dump.

Although the dump material is relatively free from acid-consuming constituents, other than copper minerals, it is anticipated that approximately 30% solution losses will occur. Thus, of 4,800 gal. a minute irrigated on top of the dump, only approximately 3,350 gal. of copper-bearing pregnant solution reaches the collecting pond at bottom. This is because of natural evaporation, absorption by the dump material, and seepage into the ground.

The collecting pond at the bottom of the dump is formed by a small concrete dam which also supports a pumping station. On top of the dam two existing pumps are equipped with 400-h.p. vertical turbine electric motors and each pumps up to 1,800 gal. per minute.

From the collecting pond the copper-bearing solution is pumped uphill through another plastic-lined pipeline to the leach plant on the mesa. The pumping distance is 4,500 ft. and the vertical lift 650 ft. Here, close to the sulphuric acid plant, the pregnant solution (containing copper sulphate) is discharged from the pipeline into a special plastic-lined surge pond. This 1,400,000-gal. pond is 264 ft. long, 114 ft. wide, 7 ft. deep, and the bottom completely covered with an aluminium-coated Koroseal polyvinyl plastic sheet. The pond was simply scooped out of the earth and has no special base other than the plastic sheet, which is 280 ft. long, 130 ft. wide, and 8 mills thick. It is impervious to most chemicals, mildew resistant, and will last indefinitely with proper care.

From the surge pond the copper-bearing solution flows by gravity to the nearby precipitating launders. Here, at a flow rate of 3,350 gal. per minute, the solution containing copper sulphate circulates through a series of cells containing shredded tin cans. There are a total of 10 double precipitating cells 9½ ft. by 10 ft. by 30 ft. deep, made of reinforced concrete. A stainless-steel screen is placed 13 ft. down from the top of each cell to hold the shredded scrap.

The cells are charged with an overhead three-ton semi-automatic loading device. Two 48-in. magnets designed for shredded iron move back and forth keeping the cells filled from a three-day storage supply alongside the launders. Each magnet has a load cell which sends information to a totalizing device that keeps a record of the tonnage deposited in the individual cells. The loading device requires an operator for starting and stopping only.

For each pound of cement copper produced 1½ lb. to 2 lb. of burned shredded tin cans are needed. These are purchased from Las Vegas, Nevada (300 tons a month), Phoenix, Arizona (100 tons a month), and Los Angeles, California (6,700 tons a month). The mud precipitate settles to the bottom and is pumped to a holding cell at the head of the launders. This pumping is done with 10 pumps (one for each two cells) powered by induction motors. From the holding cell the cement copper mud is then pumped by another unit to a 2,200-r.p.m. centrifuge that

dewaters the precipitate to 15% moisture. Overflow from the centrifuge goes back to the precipitating cells.

From the centrifuge the dewatered cement copper drops onto an 18-in. wide conveyor that carries it 20 ft. to a concrete loading pad. Here, a 1¼-yd. Payloader loads tractor-trailer trucks that take the cement copper (averaging 70% to 80% Cu) to the Hillside railroad siding. From there it is shipped to the American Smelting and Refining Company smelter at El Paso, Texas.

At the end of the launders the barren acid solution, now devoid of copper, flows by gravity to two 500,000-gal. conditioning ponds. Here, fresh sulphuric acid is added to bring it up to a strength of 7½ g. acid per litre of water and the dilute solution is again sent to leach the oxide dump. Acid consumption in the circuit is approximately 10 lb. acid for each pound of copper.

Water for the acid-leach-precipitation operations is piped from Burro Creek, some seven miles away. During dry summer months, though, this small creek dries up, so deep wells in the area have become the source of supply.

Effects of Temperature on Coal Flotation

The results of a laboratory investigation of the effect of temperature on the flotation of coal is given in Report of Investigations 5852 of the United States Bureau of Mines. The authors, J. B. Gayle and W. H. Eddy, say that although heated circuits frequently have been employed in the conditioning stages of certain flotation processes, particularly the flotation of fluorite, the control of temperature is not generally considered economically feasible for the flotation of coal. The investigation described in the Report was undertaken to obtain information about the effects of changes in pulp temperature on coal flotation recovery and also on the selectivity of separation possible using different reagents. The results indicated that flotation recoveries were markedly affected by temperature variations when certain reagents, particularly simple aliphatic alcohols, were used. For other reagents, particularly kerosine, flotation recoveries were substantially independent of variations in pulp temperature. Release-analysis results indicated that temperature variations did not greatly affect the selectivity of separation possible with the reagents tested.

The coals tested were grab samples of run-of-mine or washed coking coals from nearby coal-washing plants and coke works. Each sample was crushed and screened to obtain the range of particle sizes required for testing. In the early stages of the investigation emphasis was placed on the problem of flotation rates and the representation of flotation data by use of specific flotation rate constants. Because this approach to flotation is somewhat complicated by the presence of non-floatable material in the system previously cleaned coals were selected for many of the tests. Later in the study emphasis was shifted to the determination of recovery level and selectivity; therefore, raw coals were used for the remaining tests. Coals previously cleaned with flotation cells were purposely excluded to preclude possible difficulties in interpretation caused by residual quantities of reagents.

The reagents included: (1) Kerosine and kerosine-frother combinations (usually a 20 to 1 mixture of kerosine and pine oil), which tend to coat the coal particles and probably lead to flotation through an agglomerating mechanism; (2) simple aliphatic alcohols, which function principally as frothers by decreasing surface tension; (3) a water-miscible synthetic frother said to be of the alcohol type, which probably acts similarly to the aliphatic alcohols, and (4) sodium chloride, which probably functions exclusively as a frother by increasing the surface tension slightly. These reagents were selected because they cover most of the range of characteristics of reagents used for coal flotation. Reagent quantities were varied to obtain the intermediate levels of recovery necessary for a sensitive determination of the effects of temperature on flotation behaviour.

Batch tests were carried out with a 2,000-g. cell of the sub-aeration type. The operating cell volume was approximately 8 litres, exclusive of air, and the impeller speed was approximately 1,600 r.p.m. The cell was fitted with a specially-designed water jacket having a volume of 19 litres. The temperature of the water in the jacket was lowered by adding ice or raised by means of two 500-W immersion-type heaters connected to a variable transformer which was adjusted for the desired temperature. This arrangement permitted control of pulp temperature to within 1° C. over the range of 2° to 73° F.

To carry out a test approximately 7 litres of water was added to the cell and allowed to

come to equilibrium at the desired temperature. Air-dried coal (1,000 g.) was then added, the water level adjusted by adding water previously heated or cooled to the desired temperature, and the pulp conditioned for 5 min. with the air intake closed. Reagents were added and conditioning was continued for another 3 min. The air intake was then opened and the float material was raked off until the rate of recovery became negligible; meanwhile the level in the cell was being adjusted by adding water from time to time.

Release-analysis tests were carried out with the 2,000-g. cell used for batch testing. The procedure was that recommended by Dell and was intended to provide an indication of the maximum selectivity of separation possible at different temperatures when effects due to mechanical entrapment were minimized. The procedure involved one roughing and two cleaning operations and yielded four float and one tailing product.

A cell similar to that used for batch testing but not equipped with a water jacket was used for continuous testing. Air-dried coal was supplied by a belt-type feeder, water by a calibrated orifice used in conjunction with a constant-head reservoir, and reagents by bucket-type feeders and constant-head drip pots. In some of the tests coal, water, and reagents were fed directly to the cell intake; in other tests they were fed to an overflow-type conditioner fitted with a high-speed stirrer and placed in the circuit just ahead of the flotation cell. The volume of the conditioner was approximately 8 litres, which resulted in a conditioning time of about 1 min. Similar trends were noted for tests with and without the conditioner. Pulp temperatures were controlled by mixing varying proportions of hot and cold water. Temperatures that could be obtained in this manner ranged from about 3° to 70° C. and were measured by a thermometer located in the standpipe through which the tailings discharged from the cell.

In carrying out a test approximately 60 lb. of air-dried coal was placed in the hopper and the coal, water, and reagent feeders were adjusted to deliver the required quantities. The impeller was started and the cell was filled with water and reagents, after which the coal feed was started. Results of preliminary tests indicated that approximately 6 min. operating time was required to reach equilibrium, after which timed samples of float and tailing products were collected simultaneously. For most tests the duration of the sampling period was 1 min. and two or more samples, usually separated by 1-min. intervals, were taken at each temperature level.

Inspection of the data suggested that the relation between temperature and recovery for both batch and continuous tests was markedly influenced by the particular reagent used for testing but was substantially independent of the particular coal used.

Discussing the results illustrated in the Report the authors say that the observed effects of changes in temperature on flotation behaviour do not appear consistent with any mechanism involving chemical interactions. Therefore bubble formation and attachment in the coal flotation process probably are largely dependent on physical factors. Previous work showed that contact angles for oiled coals were not greatly influenced by temperature variations; this finding is in agreement with the substantially constant flotation recoveries obtained at different temperatures in the present investigation when kerosine was used as one of the reagents. Previous studies also showed that contact angles with methyl isobutyl carbinol either increased or remained substantially constant with increasing temperature, depending on the quantity of reagent used. Flotation recoveries obtained in the present investigation with this reagent and with the similar reagents, normal amyl and tertiary amyl alcohols, consistently decreased with increasing temperatures. This suggests that, at least in some instances, marked variations in contact angles measured by captive-bubble techniques may be outweighed by other factors in determining flotation behaviour.

Inasmuch as sodium chloride presumably has, the authors say, no affinity for coal surfaces flotation recoveries using this reagent may be correlated with contact angles measured in distilled water. Although trends for these variables are superficially related in that each tended to give maximum values at intermediate temperatures the flotation recoveries gave no indication of a range of poor or negligible floatability at approximately 20° to 30° C. as noted for the contact angles. This suggests that contact angles measured for specific particles may not necessarily reflect the statistical averages for an infinite number of particles that constitute a flotation system.

Results for batch and continuous flotation tests indicated similar effects of variations in pulp temperature on recoveries obtained with the various reagents. Changes in the quantity of floatable material in turn probably reflect both changes in the various interfacial tensions

comprising the system and mechanical conditions in the cell associated with the quantity and character of the froth produced.

The results of release-analysis tests with the various reagents indicate that, for the most part, variations in temperature have no major influence on the selectivity of separations possible with the different reagents when the effects of mechanical entrapment are minimized.

Trade Paragraphs

Padley and Venables, Ltd., of Dronfield, Sheffield, issue a leaflet which illustrates in diagrammatic form correct methods of heating for the reforging and hardening of breaker steels.

International Combustion (Export), Ltd., of 19, Woburn Place, London, W.C. 1, are issuing an illustrated folder which gives particulars of Ty-Rock full-floating screens and especially of the two heavy-duty types in large-scale plants.

Victor Products (Wallsend), Ltd., of Wallsend-on-Tyne, have compiled a well-illustrated booklet describing their tungsten carbide tipped drill steels. This indicates the ranges of lengths available and shows diagrammatically the shapes included. Copies in French, Spanish, and German are, or will be, available shortly.

Rapid Magnetic, Ltd., of Lombard Street, Birmingham, 12, introduce their WY/WZ range of electro-magnetic chute separators for extracting fine iron present in free-flowing processed material. Tapered-pole units are incorporated and a magnetically-held bridge ensures that in the event of a power failure the untreated material is diverted from the main flow.

Cyanamid International, Mining Chemicals Department, of 30, Rockefeller Plaza, New York (British representatives : Cyanamid Great Britain, Ltd., Bush House, London, W.C. 2), have issued two illustrated leaflets to call attention to applications of their AM-9 chemical grout for controlling water seepages and soil stabilization, originally mentioned in the MAGAZINE for August, 1960.

Simmonds Aerocessories, Ltd., of Treforest, Glamorgan, a member of the Firth Cleveland Group, announce the introduction of the first precision-forged self-locking nuts to be made available in this country. Now in volume manufacture and available through the normal supply channels, the immediate range covers the internationally-known Nyloc self-locking nuts in all the sizes, in both full and thin thicknesses, from $\frac{1}{4}$ in. to $\frac{1}{2}$ in. diameter in unified fine thread.

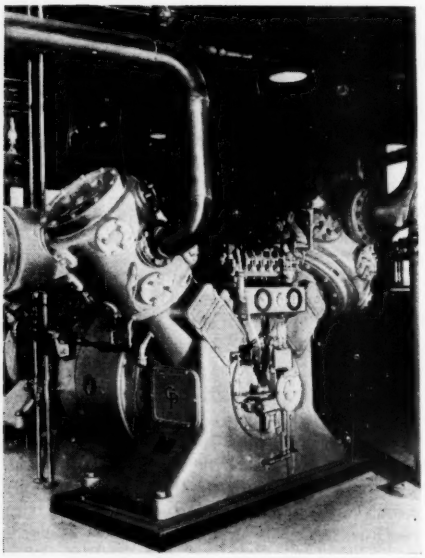
Turner Brothers Asbestos Co., Ltd., of Rochdale, have made a recent addition to the range of P.T.F.E. (Polytetrafluoroethylene) products they manufacture which is pipe thread sealing tape. This unsintered tape is supplied as a continuous ribbon $\frac{1}{2}$ in. wide on handy metal dispensers in lengths of 20 ft., 30 ft. or 40 ft., and is used for sealing threaded pipe joints at a rate never possible with previous materials. Breaking of the connexion is easily accomplished, even after a long period of time.

Lebus International Engineers, Ltd., of 28, Victoria Street, London, S.W. 1, in a recent announcement state that the arrangement whereby Woodfield Rochester, Ltd., acted as their U.K. agents has been terminated. All correspondence relating to the Lebus system of controlled multi-layer rope spooling should be sent to them at the above address. A fully illustrated booklet gives several examples of the application of this system including mine winding and haulage. It was described and illustrated in the MAGAZINE for December last.

Head Wrightson and Co., Ltd., of Ship House 20, Buckingham Gate, London, S.W. 1, call attention to an illustrated booklet recently issued by Head Wrightson, Stockton, Ltd., showing the range of their products, which include Akins classifiers, Ruggles Coles rotary dryers, ball-mills, mine headgears, aluminium-alloy mine skips. Mention is also made of the laboratory facilities available for investigation of mineral engineering and similar problems. Another booklet put out by the parent company's Research and Development Division deals with gas-cleaning cyclones.

Cable Covers, Ltd., of St. Stephen's House, Westminster, S.W. 1, are now manufacturing a cable gland which embodies a number of features and has been specially developed for use with PVC insulated cables. The major feature is adjustability whereby provision is made for many of the variables encountered in cable dimensions and accidental inaccuracies in the preparation of the cable end. It also ensures full thread engagement between the gland components irrespective of any changes in the diameter of the armouring wire. Each size will centre in two sizes of " knock-out " hole.

Consolidated Pneumatic Tool Co., Ltd., of 232, Dawes Road, London, S.W. 6, have introduced a new range of heavy-duty water-cooled double-acting, crosshead type, stationary air-compressors, in which the cylinders are set 90° apart (see illustration). Known as the Y class it is available in seven sizes with outputs of from 372 c.f.m. to 1,615 c.f.m., at



pressures of from 80 p.s.i. to 125 p.s.i., the horsepower range covered being from 75 b.h.p. to 300 b.h.p. Multistage units are available for pressures of up to 3,000 p.s.i. The compressor can be driven by a flange-mounted motor, vee-belt drive, or by a direct-coupled motor.

Eimco (Great Britain), Ltd., of Gateshead, call attention to their new Model 123 front-end loader. This 100-h.p. crawler-based machine exerts a maximum breakout force of 25,000 lb. and can operate on 1 in 1 slopes, forward or backward, with a full bucket load. It has a bucket capacity of 1¾ cu. yd. and will dump at heights up to 115 in. with a reach of 44 in. A complete cycle of lifting, tipping, and lowering the bucket is carried out by four hydraulic rams in less than 15 seconds, hydraulic power being supplied by a pump totally immersed in the oil reservoir, thus eliminating the possibility of sucking air into the hydraulic system.

Aktiebolaget Pallas, of Skeppsbron 5-6, Gothenburg, Sweden, issue some particulars of their Anfo Star—a pneumatic mixer-loader for ammonium nitrate and fuel oil for use as a blasting compound for underground work. They state that recently techniques have been developed for on-site mixing of the two materials to yield, when appropriately confined in boreholes, high-effective blasting agents. Such a mix is said to be insensitive towards pulls and strikes, so that redrilling of misfired holes can be made without risk. The Anfo Star, it is claimed, can be used for blastholes at any angle and for hole diameters down to ½ in., a hole 60 ft. in length being loaded in from one to two minutes.

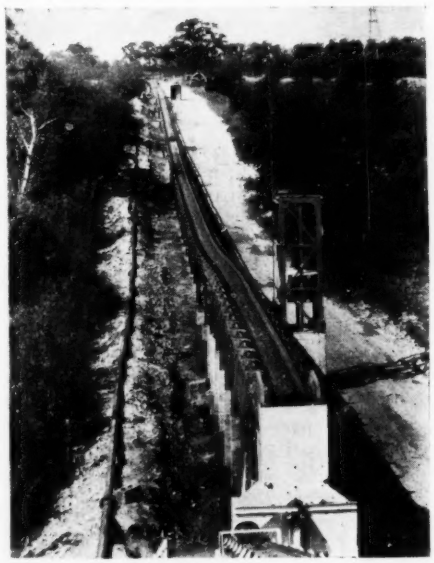
Allen West and Co., Ltd., of Brighton, 7, have acquired the Northern Ireland factory formerly occupied by Lee Guinness, Ltd., at Newtownards, Co. Down. It is not intended to transfer permanently any of the Brighton staff to Northern Ireland. The factory will immediately go over to the assembly and wiring of standard Allen West contactor panels, which will to some extent ease the pressure on the works at Brighton, where considerable developments are already taking place to meet heavily-increasing demands on the company's manufacturing resources. A new factory is being built at East Moulsecoomb and extensive alterations and additions are in progress at the head office and works at Lewes Road.

Murex Welding Processes, Ltd., of Waltham Cross, Herts, announce that extensions have recently been completed at their works. The new buildings consist of a 500 ft. long single-storey production shop having an uninterrupted floor area of 62,000 sq. ft. for the manufacture of electric-arc welding plant and a two-storey office block of 7,200 sq. ft. to accommodate the plant sales department, drawing office, and works engineer's department. The extensions represent a further stage in the planned development of the works which at the time of its erection in 1938 was considered to be the largest all-welded single-storey factory in Europe. The new buildings are designed to provide the additional accommodation required to meet the consistently increasing demand for Murex metal arc-welding electrodes and equipment both at home and abroad.

Johnson, Matthey and Co., Ltd., of 73-83, Hatton Garden, London, E.C. 1, refer to the latest series of data sheets issued covering their range of high-purity metals. In recent years, they state, the rapid advance of technical developments in many fields has brought about a demand for a wider variety of such metals and a greater diversity of physical forms. The company have investigated and perfected techniques for producing an extensive range and for fabricating many of them into rod, sheet, and other forms. In the data sheets information is given on 38 metals including noble, rare earth, and certain base and rarer metals. The general properties of each element are tabulated and details are given of the forms of current production. In most cases the metals are available in more than one grade, the metallic impurity contents being expressed in parts per million.

Mine Safety Appliances Co., Ltd., of Glasgow, have developed a ventilation smoke tube assembly to detect the speed and flow of slow moving air currents. The complete kit consists of an aspirator bulb, 12 smoke tubes, a tube breaker, and 12 rubber sealing caps. To use the detector the nipples at each end of the sealed glass smoke tubes are broken off in the tube breaker and the aspirator bulb is attached to the tube through a rubber connexion. Smoke is generated by the action of the air being passed through the chemical contained in the tube. The chemical volatilizes in contact with air so that whenever the aspirator bulb is depressed a volume of blue-white smoke is ejected from the open and of the smoke tube. The smoke-producing capacity is sufficient for at least 200 aspirations of the 2-oz. bulb. When an opened tube is not in use, or when moving from one area to another, the rubber caps are used to seal the tube ends. A replacement packet of one dozen smoke tubes measures 6 in. by 3 in. by 1 in.

Imperial Chemical Industries, Ltd., of Millbank, London, S.W. 1, again call attention to the use of Terylene in conveyor belting. The illustration shows a 2,500-ft. belt which is the second to be installed (the first being 2,000 ft. long) at a quarry in the Midlands. The belt, made by **Barrow, Hepburn and Gale, Ltd.,** of Mitcham, Surrey, from a 4-ply Terylene-cotton fabric is more flexible and stronger than previous belts supplied. The installation shown was designed and manufactured by the **Mining Engineering Co., Ltd.,** of Worcester.



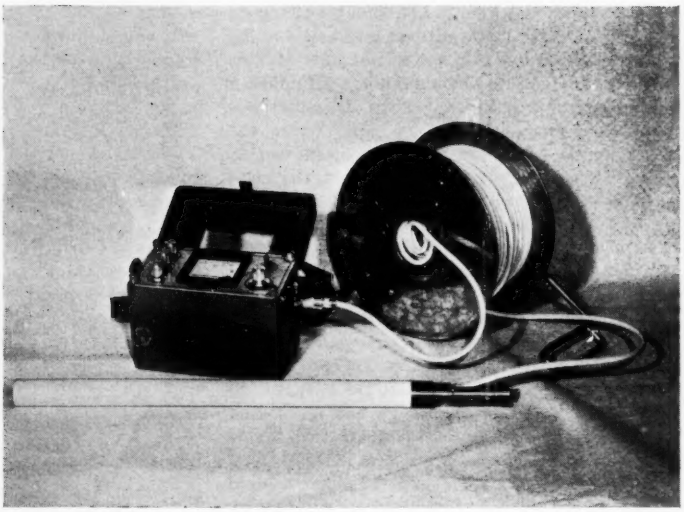
In a second notice issued recently the company refer to a new edition of their publication " Plastic Igniter Cord " by the Nobel Division. This 18-page fully illustrated booklet is more comprehensive than the first edition, in that it covers the use of P.I.C. in metalliferous mines as well as quarries, there being a considerable section devoted to underground blasting in such mines—*e.g.* in long stope, breast stope, overhand stope, development heading, and delay blasting in raise round.

Heyes and Co., Ltd., of Wigan, refer in a recent notice to a new system of draining methane gas from coal faces, developed by the N.C.B., which will enable collieries to supply methane to Gas Boards on an economical basis. The gas may also be used for the firing of colliery boilers. In this drainage system the methane is pumped up from the coal-face and stored in a gas holder. Because the quality and quantity of the gas must be carefully controlled a standard scheme has been designed specifying intrinsically-safe control and indication equipment manufactured by the company. Orders are in hand for two sets of equipment for use in such systems at the Silverwood Colliery, Nr. Rotherham, and the Prince of Wales Colliery, Pontefract. At both collieries the transformer room will house Wigan intrinsically-safe battery and charging equipment with associated control relays and valve rectifiers. Audible and visible indication of faults will be given by a 20-way trip indicator board installed in the exhauster room and a 6-way indicator board with intrinsically-safe bells in the calorimeter room. The control system is completed by various auxiliary link disconnecting boxes, flameproof indicators, and flameproof and non-flameproof switches, supplied by the company.

Buckley and Taylor, Ltd., of Castle Iron Works, Oldham, call attention to the latest addition to their range of Aquaflash plants, which has a rated output of ten tons per day and is operated by a diesel alternator, and in which they have specialized for many years. Previously these units for water distillation in arid regions have been of the diesel-driven vapour-compression type needing skilled care and attention. The diesel-electric Aquaflash is made in two portable sections : The flash distillation unit with its pumps and other ancillary equipment and the diesel generator.

Impure water is circulated in series through the tubeside of four vapour condensers, its temperature being progressively raised. After

OKI
Permeameter



leaving the highest-temperature vapour condenser the water passes through the tubeside of the diesel-engine jacket cooler where its temperature is further increased. More heat is added in an electric immersion-heater vessel before the water is introduced to the train of flash chambers, arranged in series and with progressively reduced sub-atmospheric pressures. The feed water flashes into steam in these four chambers and, in condensing in the associated vapour condensers, serves to provide heat to the incoming feed. The condensate is withdrawn from the plant by an extraction pump which discharges it to suitable storage tanks.

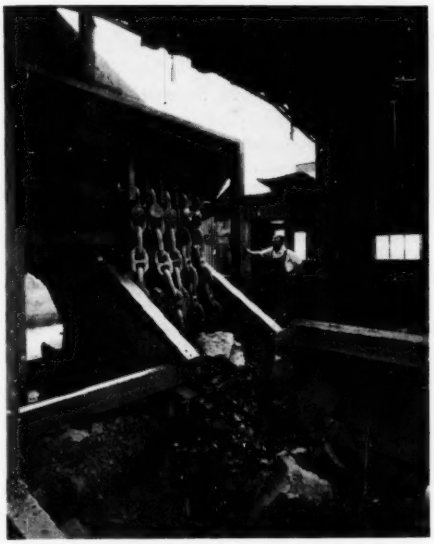
ABEM, of Danderydsgatan 11, Stockholm, announce that they have been appointed sole distributors for most of the world for the OKI Permeameter designed and developed by the Otanmäki Company, Finland. The OKI Permeameter, which received one of *World Mining's* 1961 Blue Ribbon Equipment Awards, is a compact fully-transistorized instrument for determining quickly and reliably the amount of magnetic minerals, usually magnetite (Fe_3O_4), in the walls of a small-diameter (36 mm., EX) drill-hole. Normally used when no core is available or when core recovery has been impossible—for example, when drilling in soft formations—the Permeameter makes it possible to draw accurate maps and sections showing ore content classified as high- or low-grade, disseminated ore, or waste rock.

Consisting of a drill-hole probe with a maximum diameter of $1\frac{3}{16}$ in., an indicator calibrated to give a direct reading of magnetite percentage, and the necessary cabling, the Permeameter operating procedure is simple and only requires two men who normally measure about 300 ft. of drill-hole per hour (see illustration). The instrument has been extensively used in the exploration of the big magnetite-ilmenite deposit at Otanmäki in the centre of Finland, where it has opened up new effective and economic exploitation possibilities.

General Electric Co., Ltd., of Erith, Kent, refer in a recent note to an electromagnetically-operated feeder, as illustrated, to a quarry at Nuneaton. It is a 5 ft. by 8 ft. Sherwen machine which is fed from a 30-ton capacity bunker with run-of-quarry granite up to 24-in. cube. In turn the feeder supplies a 25-in. primary gyratory crusher at 200 t.p.h., although it is capable of an output considerably above this figure. The instantaneous and infinitely-variable control of feed rate obtainable enables the varying demands of the system to be met in the minimum of time.

The company also announce that they recently received an order for blending machines to be installed in the Athus steelworks, Belgium, of S. A. Cockerill-Ougree. The equipment is to be incorporated in an ore-blending plant and comprises a reclaiming machine, transfer car, and a double-hinged boom stacker. The reclaiming machine will have a capacity of 380 t.p.h. to 500 t.p.h., depending on the density of the ores concerned, which varies between 93·3 lb./cu. ft. to 118 lb./cu. ft.

From the head office at Magnet House, Kingsway, London, W.C. 2, it is announced that



a new company, **G.E.C. (Engineering), Ltd.,** has been formed to take over and develop the engineering activities of The General Electric Co., Ltd. This is in accordance with the new policy of the G.E.C. to form its manufacturing groups into subsidiary companies. The manufacturing resources of the new company comprise the Electrical Engineering Works at Witton, Birmingham, and the Mechanical Engineering Works at Erith, Kent.

Furnascote, Ltd., of Southampton, provide some notes on their refractory protective coatings for furnaces, boilers, etc., which they believe will treble furnace life. The range offered has been developed following post-war research work and new methods of compounding to give extra protection to furnace walls, ceilings, and hearths, against the destructive action of acids produced at elevated temperatures by burning fuel oils, wood, coal, peat, etc.

Three basic types of Furnascote are made designed for differing operating temperatures : *Mortar* grade—used as a base coat for bonding and plugging. This vitrifies from 815° C. to 1,650° C. *Higlaze* grade—used as a finishing coat to reduce spalling and slagging. This vitrifies from 815° C. to 1,650° C. When Mortar and Higlaze are combined as a two-coat system the effective temperature resistance rises to 2,000° C. A monolithic, gas-tight coating is produced which has superb resistance to corrosion by sulphur compounds. *Nonvit* grade—is a special type designed to cater for lower operating temperatures needed for metals like aluminium and zinc below 815° C. It is effective from 100° C. up to 800° C. and remains effective to 1,950° C. Thus it gives a considerable range of operation. Nonvit has also been found to give excellent resistance to corrosion caused by the presence of vanadium by-products. The refractory is packed for wet and tropical climates in steel drums to prevent moisture penetration—an important factor for plants where reserve supplies must have a good " shelf-life." The drums, which hold 56 lb. of dry powder, each measure 16 in. high by 12 in. diameter. Water is added at the site and the material can be applied by unskilled labour to new or old firebricks of the furnace, by brushing or rendering a coat from $\frac{1}{8}$ in. to $\frac{1}{2}$ in. thick as needed. Thus a barrier coat is made.

Effluent and Water Treatment Exhibition and Convention

It was announced in the August issue that the second Effluent and Water Treatment Exhibition and Convention would be held in London from October 31 to November 3. Among the exhibits mention may be made of the following :—

Baird and Tatlock (London), Ltd., demonstrated a selection of their Analmatic automatic analytic equipment. One of the exhibits was the B.T.L.-Cambridge Analmatic polarograph. Process sample and supporting electrolyte are dispensed into the polarographic cell and degassed. The electrode potential is then scanned over the range appropriate to the constituent being measured and the polarogram is recorded.

Elliott Nucleonics, Ltd., displayed their new high-sensitivity water monitor which measures and records the activity of solid radio-isotopes dissolved in water. By concentrating the activity in an ion-exchange resin very low values of activity may be detected. Known quantities of water are directed through the ion-exchange resin which surrounds the G.M. tube. The signal obtained from the G.M. tube is amplified and the resultant signal is used to energize a strip-chart recording instrument.

Neldco Processes, Ltd., exhibited the Clarkson valve type " J," which consists of an alloy casting into which is fitted a specially-designed rubber sleeve. The valve is operated by low-pressure air, 30 p.s.i. being required to close it completely, and the aperture is similar to that of a normal pinch valve.

Paterson Engineering Co., Ltd., showed a selection of plant for filtration and treatment of water and effluents, with particular emphasis on

recent developments in the automation of these processes, including an automatic filter-control table together with a mimic diagram and special working models and models of the Stellar diatomaceous-earth filter.

Saunders Valve Co., Ltd., in their exhibit emphasized the use of a wider range of body materials and linings, together with greater expansion in diaphragm production and development. Items included were a silver-lined body, bodies lined with Penton thermoplastic, and titanium-lined valves. Centrifugal pumps produced by the Safran Pump Division were also displayed.

Simon-Carves, Ltd., and **Monsanto Chemicals, Ltd.,** were jointly responsible for the effluent advisory service demonstrated embracing investigation of particular effluent problems, recommendations for treatment processes, and plant design and operation.

RECENT PATENTS PUBLISHED

☛A copy of the specification of the patents mentioned in this column can be obtained by sending 3s. 6d. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C. 2, with a note of the number and year of the patent.

3225 of 1958 (881,037). J. R. GEIGY A.-G. Method for the concentration and separation of metals.

3,987 of 1958 (882,324). TITAN CO. A.S. Reduction of iron ore in a rotary kiln.

4,872 of 1958 (882,108). IMPERIAL CHEMICAL INDUSTRIES, LTD., B. R. ILES and W. A. S. WHITE. Treatment of mineral substances.

5,738 of 1958 (881,518). MC DOWELL CO. INC. Wind-box sealing construction for sintering machines.

14,692 of 1958 (882,601). PERMUTIT CO., LTD. Treatment of aqueous liquids by electrodialysis.

25,783 of 1958 (880,794). CIBA, LTD. Production of metallic niobium or tantalum by an electrolytic method.

26,882 of 1958 (881,857). NATIONAL SMELTING CO., LTD. Recovery of zinc from zinc-containing materials.

33,110 of 1958 (881,169). NATIONAL SMELTING CO., LTD. Removal of cadmium from zinc.

40,167 of 1958 (881,634). NATIONAL SMELTING CO., LTD. Sintering mixed lead and zinc sulphide materials.

17,096 of 1959 (881,997). NATIONAL RESEARCH CORPORATION. Production of tantalum powder.

38,289 of 1959 (882,456). METALLGESELLSCHAFT A.-G. Method of producing weather-resistant pellets.

NEW BOOKS, PAMPHLETS, ETC.

☛Publications referred to under this heading can be obtained through the Technical Bookshop of *The Mining Magazine*, 482, Salisbury House, London, E.C. 2.

Natural Resources in Scotland : Papers and Proceedings of a Symposium on Natural Resources, 1960, under the Chairmanship of Mr. L. A. ELGOOD. Cloth, royal octavo, 796 pages, illustrated. Price 105s. Edinburgh : The Scottish Council (Development and Industry).

Die Blei-Zink-Erzvorkommen des Ruhrgebietes und Seiner Umrandung : Monographs on the German Lead-Zinc Ore Deposits, Vol. I, part 3. By A. PILGER and others. Cloth, large octavo, 385 pages, illustrated, with 20 plates. Price 48 DM. Clausthal-Zellerfeld : Gesellschaft Deutscher Metallhütter und Bergleute e.V.

Silber : Die Metallischen Rohstoffe, Vol. 13. By R. KERSCHAGL. Cloth, octavo, 127 pages, illustrated. Price 28 DM. Stuttgart : Ferdinand Enke Verlag.

Safety in Mines Research, 1960 : 39th Annual Report of the Ministry of Power Safety in Mines Research Establishment. Paper covers. 72 pages, illustrated. Price 5s. London : H.M. Stationery Office.

Stone Dust Barriers on Coal Conveyor Roads : Report to the Coal Industry National Consultative Council Safety and Health Committee, May, 1961. Paper covers, 26 pages, illustrated. London : National Coal Board.

Metallurgical Works in Canada : Primary Iron and Steel, January, 1961. Operators List I, Part I. Paper covers, 42 pages. Price 25 cents. Ottawa : Department of Mines and Technical Surveys.

Petroleum Refineries in Canada : Operators List 5. Paper covers, 30 pages. Price 25 cents. Ottawa : Department of Mines and Technical Surveys.

British Territories in Borneo : Geological Report, 1960. Paper boards, 164 pages, illustrated. Kuching, Sarawak : Geological Survey Department.

Northern Rhodesia : The Geology of the Mapanza Mission Area ; Explanation of Degree Sheet 1626, NE Quarter. Survey Report No. 10. By R. TAVENER-SMITH. Paper covers, 41 pages, illustrated, with map. Price 15s. Lusaka : Government Printer.

Tanganyika : Ministry of Commerce and Industry, Annual Report of the Mines Division, 1960. Paper covers, 38 pages, illustrated. Price Shs. 4/50. Dar es Salaam : Government Printer.

Sierra Leone : Report of the Mines Department, 1960. Paper covers, 27 pages, illustrated. Price 3s. 6d. Freetown : Government Printer.

Selected Index to Current Literature

This section of the Mining Digest is intended to provide a systematic classification of a wide range of articles appearing in the contemporary technical Press, grouped under heads likely to appeal to the specialist.

* Article in the present issue of the MAGAZINE. † Article digested in the MAGAZINE.

Economics

***Production, Norway :** *Ilmenite, Tellnes.* Europe's Largest Ilmenite Mine in Production. J. GRINDROD, THE MINING MAGAZINE, Nov., 1961.

Production, United States : *Uranium, New Mexico.* Let's Look at Lance's Uranium Mine. R. FITCH, *Min. World* (San Francisco), Oct., 1961.

Resources, Australia : *Mineral, Queensland.* Conservation of Mineral Resources in Queensland. A. W. NORRIE, *Min. Chem. Engg. Rev.*, Sept. 15, 1961.

Resources, Australia : *Tin, N.S.W.* Aberfoyle's Plans for Ardlethan Tin Field. *Min. Chem. Engg. Rev.*, Sept. 15, 1961.

Resources, Uganda : *Mineral, Review.* The Mineral Resources of Uganda. J. W. BARNES, Geol. Surv. Uganda *Bulletin* No. 4.

***Sulphur, United States :** *Liquid, Shipping.* Shipping Sulphur in Liquid Form. THE MINING MAGAZINE, Nov., 1961.

Geology

Economic, Australia : *Lead-Zinc, N.S.W.* The Stratigraphic Succession and Structure of the Zinc Corporation and New Broken Hill Consolidated. D. S. CARRUTHERS, R. D. PRATTEN, *Econ. Geol.*, Sept.–Oct., 1961.

Economic, British Guiana : *Bauxite, Pakaraima.* Preliminary Report on the Ferruginous Bauxites of the Pakaraima Mountains. J. H. BATESON, *Geol. Surv. Mineral Resources Pamphlet* No. 10.

Economic, Egypt : *Iron, Gebel Ghorabi.* The Iron Ore Deposits of El-Bahariya Oasis, Egypt. F. M. NAKHLA, *Econ. Geol.*, Sept.–Oct., 1961.

Gold, Rhodesia : *Variation, Fineness.* Fineness of Gold in Some Southern Rhodesian Mines. H. V. EADES, *Bull. Instn. Min. Metall.*, Nov., 1961.

Mineralogy, Canada : *Pegmatite, Manitoba.* The Mineralogy of the Bernic Lake Pegmatite South-Eastern Manitoba. E. H. NICKEL, *Canad. Mines Branch Tech. Bull.*, T.B. 20.

Survey, Geochemical : *Nickel, Jamaica.* Geochemical Prospecting for Nickel in the Blue Mountain Area, Jamaica, W.I. V. G. HILL, *Econ. Geol.*, Sept.–Oct., 1961.

Survey, Geochemical : *Tin, Sediments.* Field Determination of Tin in Geochemical Soil and Stream Sediment Surveys. R. E. STANTON, A. J. MCDONALD, *Bull. Instn. Min. Metall.*, Oct., 1961.

Survey, Geophysics : *Determination, Radon.* Radon Determination as a Prospecting Technique. J. D. PEACOCK, R. WILLIAMSON, *Bull. Instn. Min. Metall.*, Nov., 1961.

Survey, Geophysics : *Electromagnetic, Canada.* Electromagnetic Studies of Iron Formations in the Lake Superior Region. F. C. FRISCHKNECHT, E. B. EKREN, *Min. Engg.*, Oct., 1961.

Survey, Geophysics : *Gravity, Utah.* Regional Gravity Survey Along the Central and Southern Wasatch Front, Utah. K. L. COOK, J. W. BERG, *U.S. Geol. Surv. Prof. Paper* 316-E.

Metallurgy

Concentrates, Lead : *Determination, Silver.* Determination of Silver in Lead Sulphide Concentrate by Atomic Absorption Spectroscopy. B. S. RAWLING and others, *Bull. Instn. Min. Metall.*, Oct., 1961.

†Copper, Leaching : *Plant, United States.* New Leach Plant at the Bagdad Copper Plant. *Min. World* (San Francisco), Aug., 1961.

Fuel, Anthracite : *Process, Agglomeration.* Agglomerating Anthracite for Metallurgical Fuel. W. S. SANNER and others, *Rep. Inv. U.S. Bur. Min.* 5843.

***Metals, Pure :** *Refining, Zone.* A Note on Zone Refining. W. H. DENNIS, THE MINING MAGAZINE, Nov., 1961.

†Ores, Beryllium : *Beneficiation, United States.* Beneficiation of Beryllium Ore. *Min. Engg.*, Oct., 1961.

Pelletizing, Iron : *Studies, Michigan.* Pelletizing Humboldt's Iron Concentrate by Grate-Kiln Process. D. M. URICH, *Min. World* (San Francisco), Oct., 1961.

Segregation, Copper : *Adoption, United States.* Copper Segregation Shows Promise at Lake Shore Mine. G. A. FREEMAN and others, *Min. Engg.*, Oct., 1961.

Machines, Materials

Conveyors, Rope : *Mines, Coal.* Rope-Driven Conveyors Underground in Coal Mines. L. WALKER, A. E. HISCOX, *Min. Engr.*, Sept., 1961.

Drills, Percussive : *Pressure, Air.* Higher Air Pressures for Down-the-Hole Percussive Drills. E. P. PFLEIDER, W. D. LACABANNE, *Mine, Quarry Engg.*, Oct., Nov., 1961.

Jib, Coal-Cutter : *Suppression, Dust.* The C.E.E. Dust-Suppression Jib. *Inform. Bull. N.C.B.* 61/230.

Motors, Electrical : *Insulation, Breakdown.* Review of Motor Installations, with Special Reference to Breakdowns by Discharges Encountered in the Mining Industry. S. C. ROBERTS, *Trans. S. Afr. Inst. Elec. Eng.*, July, 1961.

Pipelines, Buried : *Protection, Cathodic.* The Cathodic Protection of Buried Steel Pipelines. L. A. WOODWORTH, F. P. A. ROBINSON, *S. Afr. Mech. Engr.*, Sept., 1961.

Pump, Sludge : *Performance, Canada.* Milliken Continuous Settling and Sludging Pump. M. D. LAWTON, *Canad. Min. J.*, Aug., 1961.

Rocks, Properties : *Tests, Physical.* Standardized Procedures for the Determination of the Physical Properties of Mine Rock under Short-Period Uniaxial Compression. H. R. HARDY, Canad. Mines Branch *Technical Bulletin* T 8.

Winder, Electrical : *Control, Rectifier.* A Rectifier-Controlled Winder. *G.E.C. J.*, Vol. 28, No. 3, 1961.

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Alluvial, Gravel : *Grab, Floating.* Winning Sand and Gravel by Floating Grab. *Mine, Quarry Engg.*, Nov., 1961.

Breaking, Blasting : *Ammonium Nitrate, Fuel Oil.* The Application of Ammonium Nitrate—Fuel Oil Explosives in Underground Mining at Stanrock. G. G. HUNKIN and others, *Canad. Min. Metall. Bull.*, Sept., 1961.

***Breaking, Blasting :** *Process, Non-Explosive.* Non-Explosive Rock Breaking. THE MINING MAGAZINE, Nov., 1961.

Control, Subsidence : *Extraction, Partial.* Partial Extraction as a Means of Reducing Subsidence Damage. *Inform. Bull. N.C.B.* 61/231.

Handling, Winding : *Aspects, Safety.* Safety Aspects of Winding in Shafts and Staple Pits. S. J. AYRES, *Min. Elec. Mech. Eng.*, Oct., 1961.

***Hoisting, India :** *Control, Rope.* Controlled Swivel for Wire Ropes. A. SEETHARAM, THE MINING MAGAZINE, Sept., Oct., Nov., 1961.

Hygiene, Silicosis : *Dust, Suppression.* Dust Suppression Investigations. R. J. HAMILTON, K. W. MCKINLAY, *Coll. Engg.*, Oct., 1961.

Hygiene, Ventilation : *Networks, Underground.* Method of Measuring and Studying Ventilation Networks in Underground Operations. L. CHAIMEAUX, D. SEELEMANN, *Rev. l'Ind. Min.*, Aug., 1961.

Hygiene, Ventilation : *Resistance, Shaft.* The Economic Aspect of Reducing Shaft Resistance. A. W. T. BARENBRUG, *J. S. Afr. Inst. Min. Metall.*, Oct., 1961.

Hygiene, Ventilation : *Resistance, Shaft.* Ventilation Resistance Factors of Some Vertical Downcast Shafts in the Rand Mines Group. M. BARCZA, M. J. MARTINSON, *J. S. Afr. Inst. Min. Metall.*, Oct., 1961.

Open-Cast, Blasting : *Studies, Photographic.* Photographic Observation of Quarry Blasting. B. PETKOF and others, *Rep. Inv. U.S. Bur. Min.* 5849.

Subsidence, Control : *Coal, United Kingdom.* Subsidence—The Transference of Ground Movement to Surface Structures. F. P. GARDNER, G. HIBBERD, *Min. Engr.*, Oct., 1961.

Supports, Powered : *Use, United Kingdom.* An Interim Report on Powered Supports in the North-Western Division. J. G. HIND and others, *Min. Engr.*, Oct., 1961.

Ore Dressing

†**Flotation, Coal :** *Effects, Temperature.* Laboratory Investigation of the Effect of Temperature on Coal Flotation. J. B. GAYLE, W. H. EDDY, *Rep. Inv. U.S. Bur. Min.* 5852.

Flotation, Italy : *Future, Survey.* The Development and the Future of Flotation in Italy. L. USONI, Int. Conv., Denver, Sept., 1961.

†**Gravity, Sink-Float :** *Feeds, Flotation.* Preconcentration of Flotation Feeds with T.B.E. A. MITZMAGER, J. MIZRAHI, *TBE Bulletin*, Oct., 1961.

Jigs, Coal : *Cycles, Measurement.* The Measurement of Cycles on Industrial Jigs. J. A. DAVIS, R. L. WHITMORE, *Coll. Engg.*, Oct., 1961.

Particles, Size : *Measurement, Sub-Sieve.* Particle Size Measurement with a Micromerograph. J. R. MAY, *Min. Chem. Engg. Rev.*, Sept. 15, 1961.

***Sands, Beach :** *Separation, High-Tension.* Behaviour of Beach Sands in High-Tension Electrostatic Separators. K. K. MAJUMDAR, THE MINING MAGAZINE, Nov., 1961.

†**Separation, Magnetic :** *Process, Wet.* Application of the Jones Wet Magnetic Separator to the Beneficiation of Iron Ore. W. J. D. STONE, *Canad. Min. Metall. Bull.*, Sept., 1961.